

WEST AFRICAN SENIOR SCHOOL CERTIFICATE EXAMINATION
METAL WORK

PREAMBLE

The examination is designed to test candidates' skill in basic design and practical work; their knowledge of tools, equipment and materials, and understanding of those areas of creative thinking which can be expressed and developed through planning and working primarily with metals as part of general education.

OBJECTIVES

Candidates will be expected to demonstrate :

- (1) safe working habits in the workshop.
- (2) knowledge of tools, materials and equipment.
- (3) basic skills of good craftsmanship.
- (4) ability in identifying, analysing and evaluating a problem.
- (5) the ability to apply their knowledge of processes and materials to the solution of problems.
- (6) ability to translate an idea into a project design.

STRUCTURE OF THE EXAMINATION

The examination shall consist of two papers, both of which must be taken.

PAPER 1: This paper will be a practical test of 3 hours. 10 minutes shall be given prior to the commencement of the examination for the study of the drawings. Candidates will be required to make a test piece for which the appropriate drawings will be supplied. The paper will consist of two questions out of which candidates will be expected to answer one. Schools will supply materials needed. The paper carries 100 marks.

PAPER 2: This paper will be a 2½ hour theory paper consisting of two sections covering all aspects of the syllabus.

Section A (Objective):

This will consist of 40 compulsory multiple choice (objective) questions. Candidates will be allowed 1 hour for this section after which the answer sheets will be collected. This section carries 40 marks.

Section B (Essay-type):

This will consist of five essay-type questions out of which candidates will be expected to answer four questions in 1½ hours. This section carries 60 marks. All questions will carry equal marks.

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DETAILED SYLLABUS

TOPIC	TECHNOLOGY AND THEORY	PRACTICALS
1. General Safety in the workshop	<p>1.1 Potential sources of accidents in the workshop and precautions</p> <p>Personal safety: safe handling of tools, equipment and machines</p>	
2. Metals	<p>2.1 Ferrous metals; production, properties and uses – pig iron, cast iron, wrought iron and plain carbon steels. Uses of alloy steels. Furnaces: blast, puddling, open hearth, crucible, cupola, bessemer converter, electric arc, high frequency induction.</p> <p>2.2 Non-ferrous metals: identification, production, properties, uses – aluminium, copper, zinc, tin, lead.</p> <p>Non-ferrous alloys; constituents, properties and uses of brass, bronze, solders, duralumin.</p>	<p>2.1.1 Identification –</p> <ul style="list-style-type: none"> - file test - spark test
3. Hand Tools and Bench Work	<p>3.1. Identification, construction, maintenance, uses and care of hand tools; bench tools, marking out, cutting, measuring, testing and driving tools; work holding devices, safety precautions.</p>	<p>3. 1.1 Practical exercises involving the uses of hand tools.</p>
4. Heat Treatment processes	<p>4.1 Case hardening, hardening, tempering, annealing and normalizing using the Blacksmith's forge, oxyacetylene flame and ovens (furnace). Safety precautions.</p>	<p>4. 1.1 Heat treatment of hand tools. Use of colour charts.</p>
5. Forging	<p>5.1 Tools, equipment and processes; drawing down, up-setting, swaging, fullering, bending, twisting, punching, flattening and cutting, safety precautions.</p>	<p>5.1.1 Forging of chisels, center punch, scriber, door bolts, hinges, hoes, pokers etc.</p>

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TOPIC	TECHNOLOGY AND THEORY	PRACTICALS
6. Foundry Work	6.1 Casting : <ul style="list-style-type: none"> - sand casting (green sand) - materials and equipment for sand casting. - patterns (single piece, split, flat-back) - simple core making - processes – pouring, dismantling of mould and fettling. - sand casting defects (types, causes) - safety precautions. 	6. 1.1 Simple pattern making Mould making and Metal pouring
7. Metal Joining	7.1 Methods of joining: Basic equipment and processes; soft soldering, brazing, screw threads, bolts and nuts, riveting, welding – metal arc and oxy-acetylene. Types of joint (lap, butt, corner and fillet), safety precautions.	
8. Sheet Metalwork	8.1 Materials, equipment, tools and processes – pattern development, cutting, bending, sinking, raising, planishing and wiring. Safety precautions.	8. 1.1 Production of simple articles e.g. cans, funnels and bowls.
9. Machine Tools and machining	9.1 Drilling and reaming; types of drilling machines, twist drills (sizes, features and maintenance). Drilling processes and operations, safety precautions. 9.2 Power saws; types and operations, safety precautions 9.3 Grinding; types of grinders (bench and pedestal), Disc wheel. Safety precaution. 9.4 Lathe work, centre lathe, parts and functions, work holding devices, 3 and 4 jaw chucks, collets, face plates, catch plates and mandrels: Other accessories, steadies and centres. Cutting tools, materials, types of holders, (grinding and mounting).	9. 1.1 Exercises on drilling machine. Drilling, reaming, countersinking and counterboring. 9. 2.1 Using the power saws to cut materials for projects. 9.3.1 Grinding of single point tools, eg. scribers, chisels and lathe tool bits.

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TOPIC	TECHNOLOGY AND THEORY	PRACTICALS
	<p>9.5 Operations – facing, centre drilling, drilling, boring, parting off, turning in the chuck and between centres, knurling, taper turning, vee thread-cutting.</p> <p>9.6 Cutting lubricants and coolants (soluble oil, straight cutting oil, soda solution).</p> <p>9.7 Care, maintenance and safety precautions.</p>	<p>9.5.1 Operations sequence, exercises involving facing, step turning, drilling, boring, taper turning, knurling, vee thread-cutting and parting off.</p>
10. Finishes and Decorative processes	<p>10.1 Types of finishes and decorative processes - polishing and buffing, spot facing, planishing, colouring, plating, etching, lacquering and pickling.</p>	<p>10.1.1 Application of finishes on projects.</p>
11. Design	<p>11.1 Element, principles, trends and kinds. Design procedures and problems – data collection and analysis, Selection of possible solution, Free hand sketching, working drawings, prototype, testing and production.</p>	<p>11.1.1 Project design showing the various stages. Tables of specification and bill of materials.</p>

LIST OF MATERIALS AND EQUIPMENT FOR METALWORK WORKSHOP

Recommended workshop size:

Purpose-built 14 m length x 8m width x 4m height, well ventilated and illuminated.

Safety Equipment and Materials:

Fire extinguishers, first aid box, buckets of sand, CO₂ wall charts etc.

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1. **Workshop Tools**

- (a) Cutting tools; Hacksaw, drills, chisels, snips, files, stock and die, scrappers, reamers.
- (b) Measuring tools; Steel rules, inside and outside calipers, combination square, micrometer screw gauges, vernier gauges, vernier protractors, spirit level, dial gauges,
- (c) Marking out tools; Surface gauge, surface plate, try square, vee-block, dividers, odd leg calipers, trammels, straight edge, scriber, angle plates, centre punches.
- (d) Driving tools; pin punches, screwdrivers, hammers, drifts.
- (e) Work holding devices; clamps, vices, pliers, mole grips, self gripping wrenches.
- (f) Forging tools; hardies, fullers, tongs, swages, anvils, anvil stands, letter stamps and stakes, sand bag.

2. **Workshop Equipment**

Work benches, marking out table, blacksmith's hearth, foundry furnace, sets of tool boxes, oil cans.

3. **Machine tools**

Centre lathe (with accessories), sensitive and pillar drilling machines, pedestal grinder, power hacksaw, folding machine, shears, rolling machine, etc.

Welding Equipment

Standard arc welding machine with accessories, electrodes, shields, aprons, chipping hammers, Welding boots, etc. standard oxygen and acetylene cylinders, Filler rods, spark lighters, Regulators, nozzles, etc.

Materials

Mild steel round bars, (03 mm – 050 mm) Flat bars (of different sizes), Square bars, Hexagonal bars, Mild steel sheets, and plates, Galvanized and tinned sheets. (Projects may be constructed with non-ferrous metals e.g. Copper, Aluminum, Brass).

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SOME RECOMMENDED TEXT BOOKS FOR METAL WORK

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| 1. | Workshop Technology (Parts 1 and 2) | - | W.A.J. Chapman |
| 2. | Metalwork Technology | - | G.H. Thomas |
| 3. | Metal Technology | - | C.E.S.A.C. |
| 4. | Introductory Technology | - | C.E.S.A.C |
| 5. | Welding Technology | - | Gourd |
| 6. | Mechanical Engineering practice | - | A. Green and W.H. Howe |
| 7. | Crafts Theory and Related Studies | - | R.T. Pritchard Vol. 1 & 2 |
| 8. | Mechanical Engineering | - | R.L. Timings |
| 9. | Metalwork Theory, Books 1, 2, 3, & 4
(Metric Edition) | - | P.F. Lye – Harrap, Lon |
| 10. | Design Technology in Metal and Plastics
(Metric Edition) | - | G.H. Thomas– John Murray |
| 12. | Jab Metalwork Projects; for African Schools
and Colleges | - | R. Edward – Cassel, Lon |
| 13. | Basic Engineering Processes | - | S. Crawford |
| 14. | Metalwork | - | R. Sandham
& F.R. Willmers |
| 15. | Workshop Processes and Materials | - | J. V. Courtney |
| 16. | Metalwork Projects and Theory (S.I. Units) | - | K. Parkinson |
| 17. | The Theory and Practice of Metalwork (3 rd Edition) | - | G. Love |
| 18. | Metalwork for Schools and Colleges | - | J. N. Green |