# MECHANICAL TECHNOLOGY: WELDING AND METALWORK

# EXEMPLAR 2018

**MARKING GUIDELINES**

# NATIONAL

# SENIOR CERTIFICATE


# GRADE 12

**MARKS: 200**

**These marking guidelines consist of 18 pages.**

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| **QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)** |  |  |

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| 1.1 | A ✓ |  | (1) |

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| 1.2 | B ✓ |  | (1) |

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| 1.3 | B ✓ |  | (1) |

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| 1.4 | B ✓ |  | (1) |

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| 1.5 | C ✓ |  | (1) |

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| 1.6 | C ✓ |  | (1) |
|  |  | **[6]** |

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| **QUESTION 2: SAFETY (GENERIC)** |  |  |

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| 2.1 | **Machine safety rule:**Switch machine off after use. ✓ |  | (1) |

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| 2.2 | **Drill press safety precautions:**Clamp the work piece securely to the table and do not hold it by hand. ✓  |  | (1) |

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| 2.3 | **Hydraulic press safety rules:*** Predetermined pressure must not be exceeded. ✓
* Pressure gauge must be tested regularly and replaced if malfunction occurs. ✓
* The platform must be rigid and square to the cylinder. ✓
* Objects to be pressed must be placed in suitable jigs. ✓
* Ensure that the direction of pressure is always at 90° to the object. ✓
* Only prescribed equipment must be used. ✓ **(Any 2 x 1)**
 |  | (2) |

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| 2.4 | **Reasons for wearing surgical gloves:*** To prevent HIV/Aids or any blood related infections. ✓
* To prevent contamination of the open wounds. ✓
 |  | (2) |

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| 2.5 | **Gas cylinder safety precautions:*** Always store and use gas cylinders in an upright position. ✓
* Never stack cylinders on top of one another. ✓
* Do not bang or work on the cylinders. ✓
* Never allow cylinders to fall. ✓
* No oil and grease should come into contact with gas cylinders or fittings. ✓
* Keep the caps on the cylinders for protection. ✓ **(Any 2 x 1)**
 |  | (2) |

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| 2.6 | **Responsibility of employer:** * Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
* Eliminate or reduce any hazard or potential hazard. ✓
* Produce, handle, store and transport goods safely. ✓
* Ensure that every person employed complies with the requirements of this Act. ✓
* Enforce measures if necessary in the interest of health and safety. ✓
* Appoint a person who is trained and who have the authority to ensure that employee take precautionary measures. ✓ **(Any 1 x 1)**
 |  | (1) |

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| 2.7 | **Responsibility of employee:*** Pay attention to your own and other people's health and safety. ✓
* Co-operate with the employer regarding the Act. ✓
* Carry out a lawful order given to them. ✓
* Report any situation that is unsafe or unhealthy. ✓
* Report all incidents and accidents. ✓
* Do not interfere with any safety equipment or misuse such equipment. ✓
* Obey all safety rules. ✓ **(Any 1 x 1)**
 |  | (1) |
|  |  | **[10]** |

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| **QUESTION 3: MATERIALS (GENERIC)** |  |  |

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| 3.1 | **Metal tests:**  |  |  |

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|  | 3.1.1 | **Filing test:**Filing should be done on the tip or near the edge ✓ of the material to establish the relative hardness. ✓ |  | (2) |

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|  | 3.1.2 | **Machining test:**This test is used on two unknown samples, identical in appearance and size, which is cut with a machine tool at the same speed and feed. ✓ The ease of cutting should be compared and the chips observed for heating colour and curl. ✓ |  | (2) |

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| 3.2 | **Sound test on the steel:**  |  |  |

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|  | 3.2.1 | **High carbon steel (Hard):**Loud and clear ✓✓ |  | (2) |

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|  | 3.2.2 | **Low carbon steel (Soft):**Dull sound ✓✓ |  | (2) |

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| 3.3 | **Heat treatment processes on steel:** |  |  |

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|  | 3.3.2 | **Case hardening:**To produce a hard case ✓ over a tough core. ✓ |  | (2) |

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|  | 3.3.3 | **Hardening:**To enable the steel to resist wear ✓ and indentation ✓  |  | (2) |

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|  | 3.3.5 | **Normalising:**To relieve ✓ the internal stress ✓ produced by machining.  |  | (2) |
|  |  | **[14]** |

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| **QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)** |  |  |

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| 4.1 | C ✓ |  | (1) |

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| 4.2 | B ✓ |  | (1) |

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| 4.3 | A ✓ |  | (1) |

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| 4.4 | C ✓ |  | (1) |

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| 4.5 | A ✓ |  | (1) |

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| 4.6 | C ✓ |  | (1) |

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| 4.7 | B ✓ |  | (1) |

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| 4.8 | D ✓ |  | (1) |

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| 4.9 | A ✓ |  | (1) |

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| 4.10 | D ✓ |  | (1) |

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| 4.11 | B ✓ |  | (1) |

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| 4.12 | D ✓ |  | (1) |

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| 4.13 | A ✓ |  | (1) |

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| 4.14 | C ✓ |  | (1) |
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| **QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)** |  |  |

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| 5.1 | **Roof truss:**A – Principal rafter ✓B – Cleat ✓C – Purlin ✓D – Internal bracing members ✓E – Gusset plate ✓  |  | (5) |

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| 5.2 | **Fillet weld on T-joint:**Arc550 – 100 ✓✓✓✓✓✓✓✓ |  | (8) |

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| 5.3 | **Dimensions of the material:**  |  |  |

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✓

✓

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|  | 5.3.1 |  |  | (6) |

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|  | 5.3.2 | 16 mm230 mm246 mm✓✓✓✓ |  | (4) |
|  |  | **[23]** |

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| **QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)** |  |  |

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| 6.1 | **Working principle of the following machines:** |  |  |

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|  | 6.1.1 | **Punch and cropping machine:**Cropping machines are electrically driven ✓ and use a heavy fly wheel and clutches ✓ to engage various shearing blades/punches ✓ to shear/punch the various profiles. ✓ |  | (4) |

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|  | 6.1.2 | **Spot welding equipment:**This method uses the heating effect, ✓ which occurs when a current flows ✓ through a resistance, ✓ to fuse two plates together. ✓ |  | (4) |

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|  | 6.1.3 | **Power-driven guillotine:**An electric motor ✓ drives a fly wheel in a gearbox ✓ that is activated through the electric pedal and clutch ✓ to turn an axle that lowers the blade by eccentric motion/action. ✓ |  | (4) |

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| 6.2 | **Uses of the bench grinder:*** To sharpen cutting tools and drill bits. ✓
* To remove rough edges. ✓
* To remove excess material. ✓
 |  | (3) |

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| 6.3 | **Types of rolling machines:*** Horizontal pyramid rolls ✓
* Off-set pinch rolls ✓
* Vertical rolls ✓
 |  | (3) |
|  |  | **[18]** |

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| **QUESTION 7: FORCES (SPECIFIC)** |  |  |

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| 7.1 | ✓✓✓✓✓✓✓✓

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| **Member** | **Force** | **Nature** |
| AE | 20 kN ✓ | Strut ✓ |
| EF | 40 kN ✓ | Strut ✓ |
| FC | 34 kN ✓ | Strut ✓ |
| BF | 20 kN ✓ | Tie ✓ |
| DE | 17 kN ✓ | Tie ✓ |

Space diagram1 : 100Vector diagram2 mm = 1 kN |  |  |
|  |  |  |  | (20) |

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| 7.2 | **4 kN****5 kN****6 kN****3 m****3 m****3 m****3 m****D****C****B** **A****E****D****C****B****A****E****RR****RL** |  |  |

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|  | 7.2.1 | ✓✓✓✓✓✓ |  | (6) |

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|  | 7.2.2 | **Shear forces:**✓✓✓✓✓ |  | (5) |

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|  | 7.2.3 | **Bending moments:**✓✓✓✓✓ |  | (5) |

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|  | 7.2.4**+****=****A****0** | **Shear force diagram:****B****E****D****C**✓✓**–****=**✓✓ | **0** | (4) |

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|  | 7.2.5**0****A** | **Bending moment diagram:****B****C****D****E**✓✓✓**0**✓✓ |  | (5) |
|  |  | **[45]** |

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| **QUESTION 8: JOINING METHODS (INSPECTION OF WELD) (SPECIFIC)** |  |  |

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| 8.1 | **Inspection during arc welding:*** Amount of penetration and fusion ✓
* Rate of electrode burning and progress of the weld ✓
* The way the weld metal is flowing (no slag inclusion) ✓
* The sound of the arc, indicating correct current and voltage for the particular weld ✓ **(Any 3 x 1)**
 |  | (3) |

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| 8.2 | **Causes of weld defects:** |  |  |

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|  | 8.2.1 | **Welding spatter:*** Too high current ✓
* Too long arc ✓
* Not applying anti-spatter spray ✓
* Electrode angle too small ✓
* Welding speed too fast ✓ **(Any 2 x 1)**
 |  | (2) |

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|  | 8.2.2 | **Incomplete penetration:*** Too low current ✓
* Too slow welding speed ✓
* Electrode angle too small ✓
* Poor joint preparation ✓
* Insufficient root gap ✓ **(Any 2 x 1)**
 |  | (2) |

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| 8.3 | **Prevention of weld defects:** |  |  |

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|  | 8.3.1 | **Porosity:*** Ensure that the surface is clean. ✓
* Prevent atmospheric contamination. ✓
* Use dry electrodes. ✓  **(Any 1 x 1)**
 |  | (1) |

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|  | 8.3.2 | **Slag inclusion:*** Remove slag from previous run before doing the next run. ✓
* Ensure that the surface is clean. ✓
* Use the correct current. ✓ **(Any 1 x 1)**
 |  | (1) |

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| 8.4 | **Nick-break test**:To determine the internal ✓ quality/defects ✓ of the weld metal.  |  | (2) |

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| 8.5 | **Guided bend test:*** Lack of fusion of the base metal and weld metal. ✓
* Incomplete penetration of the weld metal. ✓
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| 8.6 | **Free-bend test:**Ductility ✓ |  | (1) |

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| 8.7 | **Visual inspection process:*** Shape of profile ✓
* Uniformity of the surface ✓
* Overlap ✓
* Undercutting ✓
* Penetration bead ✓
* Root groove ✓ **(Any 3 x 1)**
 |  | (3) |

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| 8.8 | **Liquid dye penetration test:*** Clean the surface tested. ✓
* Spray the liquid dye penetrant onto the surface. ✓
* Allow liquid dye to penetrate. ✓
* Remove excess dye with cleaner. ✓
* Spray a developer onto the surface to bring out the colour. ✓
* Areas where the dye has penetrated (defects) will show up clearly. ✓
 |  | (6) |
|  |  | **[23]** |

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| **QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)** |  |  |

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| 9.1 | **Distortion:**Weld distortion is the warping of the base metal ✓ caused by heat from the welding arc/flame. ✓ |  | (2) |

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| 9.2 | **Residual stress:**As the weld proceeds, ✓ the surrounding areas expand and contract ✓ at varied rates, which set up stresses ✓ in the welded joint. These stresses remain when the weld has cooled ✓ and are known as residual stresses.  |  | (4) |

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| 9.3 | **Distortion and residual stress:*** If expansion, which occurs when a metal is heated, is resisted then deformation occurs. ✓
* When contraction, which occurs on cooling, is resisted then a stress will be applied. ✓
* If the applied stress causes movement, then distortion occurs. ✓
* If the applied stress does not cause movement, then there will be residual stress in the welded joint. ✓ **(Any 3 x 1)**
 |  | (3) |

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| 9.4 | **Methods to reduce distortion:*** Do not overweld. ✓
* Apply intermittent welding. ✓
* Place welds near the neutral axis. ✓
* Use as few passes as possible. ✓
* Use back-step welding. ✓
* Anticipate the shrinkage forces. ✓
* Plan the welding sequence. ✓
* Use strongbacks. ✓
* Use clamps, jigs and fixtures. ✓ **(Any 3 x 1)**
 |  | (3) |

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| 9.5 | **Difference between cold working and hot working of steel:**Cold working is when deformation of steel takes place below ✓ the recrystallisation temperature ✓ of the steel.Hot working is when deformation of steel takes place above ✓ the recrystallisation temperature ✓ of the steel. |  | (4) |

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| 9.6 | **Factors that affect the grain size of steel:*** The prior amount of cold work. ✓
* The temperature and time of the annealing process. ✓
* The composition. ✓
* The melting point. ✓ **(Any 2 x 1)**
 |  | (2) |
|  |  | **[18]** |

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| **QUESTION 10: MAINTENANCE (SPECIFIC)** |  |  |

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| 10.1 | **Locking out of large machines before maintenance:*** Due to the danger associated with large machines ✓
* To ensure that isolation switches are switched off ✓
* To ensure that switches are locked out and tagged to inform others that maintenance work is being done ✓
* To ensure that nobody can turn on the machine while maintenance is being done ✓ **(Any 2 x 1)**
 |  | (2) |

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| 10.2 | **Tagging plates:**It has multiple holes so that more than one technician can lock out the machine simultaneously. ✓ |  | (1) |

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| 10.3 | **Major and minor services for power-driven guillotine:****Major** service allows for on-going service procedures that are designed to maintain the guillotines in premium working conditions. ✓**Minor** service is designed to minimise major mechanical and electrical failures, by employing the principle of preventative maintenance. ✓ |  | (2) |

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| 10.4 | **Maintenance guidelines for a pedestal drilling machine:*** Visual checks of electrical wiring, switches, etc. ✓
* Verify that all guards are secure and function correctly. ✓
* Ensure workspace is clear. ✓
* Confirm availability and conditions of PPE. ✓
* Lubricate moving parts. ✓
* Use moisture-penetrating oil spray to prevent rust. ✓
* Check for availability of specific tools. ✓
* Check the run-out of the spindle. ✓
* Inspect belts for wear. ✓
* Ensure the drive belt is correctly tensioned. ✓
* Check the condition of the rack and pinion mechanisms and lubricate. ✓
* Ensure cuttings are removed. ✓
* Inspect the Morse taper sleeves for burrs/scratches. ✓
* Check the security of machine mountings. ✓ **(Any 2 x 1)**
 |  | (2) |

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| 10.5 | **Overloading a punch and shearing machine:*** Dulling or breaking blades/punches. ✓
* Putting strain on the motor and drive mechanism. ✓ **(Any 1 x 1)**
 |  | (1) |
|  |  | **[8]** |

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| **QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)** |  |  |

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| 11.1 | **Conical hopper:** |  |  |

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|  | 11.1.1 | **Vertical height (DE):**✓✓  |  | (2) |

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|  | 11.1.2 | **Main radius (AC):** ✓✓ |  | (2) |

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|  | 11.1.3 | **Small radius (AD):**✓✓✓  |  | (3) |

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|  | 11.1.4 | **Circumference:**✓✓ |  | (2) |

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| 11.2 | **Square-to-round transition piece:** |  |  |

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|  | 11.2.1 | **The true length FG is firstly needed to draw the pattern:**✓✓✓✓✓ |  | (5) |

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|  | 11.2.2 | **To determine the plan length CI, the sides CE and EI of triangle CEI must be calculated.**✓✓✓✓ |  | (4) |

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|  | 11.2.3 | **JI is one-twelfth of the circumference** ✓✓✓ |  | (3) |
|  |  | **[21]** |

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| **TOTAL:** |  | **200** |