



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY**

**FEBRUARY/MARCH 2011**

**MEMORANDUM**

**MARKS: 200**

**This memorandum consists of 15 pages.**

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS****(Learning Outcome 3: Assessment Standard 1 – 9)**

- |      |    |     |
|------|----|-----|
| 1.1  | D√ | (1) |
| 1.2  | A√ | (1) |
| 1.3  | D√ | (1) |
| 1.4  | D√ | (1) |
| 1.5  | B√ | (1) |
| 1.6  | C√ | (1) |
| 1.7  | A√ | (1) |
| 1.8  | C√ | (1) |
| 1.9  | D√ | (1) |
| 1.10 | A√ | (1) |
| 1.11 | D√ | (1) |
| 1.12 | B√ | (1) |
| 1.13 | B√ | (1) |
| 1.14 | C√ | (1) |
| 1.15 | A√ | (1) |
| 1.16 | C√ | (1) |
| 1.17 | D√ | (1) |
| 1.18 | A√ | (1) |
| 1.19 | C√ | (1) |
| 1.20 | D√ | (1) |
- [20]**

**QUESTION 2: FORCES AND SYSTEMS AND CONTROL****(Learning Outcome 3: Assessment Standard 6 and 8****2.1 Stress and strain**2.1.1 Compression Stress √ (1)

2.1.2 Stress in material

$$A = \frac{\pi(D^2 - d^2)}{4}$$

$$= \frac{\pi(0,04^2 - 0,03^2)}{4}$$

$$= 0,55 \times 10^{-3} \text{ m}^2$$

$$\sigma = \frac{F}{A}$$

$$= \frac{23 \times 10^3}{0,55 \times 10^{-3}}$$

$$= 41,84 \text{ MPa}$$
√  
√  
√  
√  
√ (5)

2.1.3 Shortening of bush

$$\varepsilon = \frac{\sigma}{E}$$

$$= \frac{41,82 \times 10^6}{90 \times 10^9}$$

$$= 0,46 \times 10^{-3}$$

$$\Delta l = ol \times \varepsilon$$

$$= 80 \times (0,46 \times 10^{-3})$$

$$= 36,8 \times 10^{-3} \text{ mm}$$
√  
√  
√ (5)

**2.2 Hydraulic****2.2.1 Fluid pressure**

$$A_p = \frac{\pi D_p^2}{4}$$

$$= \frac{\pi \times 0,038^2}{4}$$

$$= 1,13 \times 10^{-3} \text{ m}^2$$

√

$$p = \frac{F_p}{A_p}$$

$$= \frac{200}{1,13 \times 10^{-3}}$$

$$= 0,18 \text{ MPa or } 176348,9674 \text{ Pa}$$

√

√ (3)

**2.2.2 Diameter of ram**

$$A_r = \frac{F_r}{p}$$

$$= \frac{23 \times 10^3}{0,18 \times 10^6}$$

$$= 0,13 \text{ m}^2$$

√

√

$$A = \frac{\pi D^2}{4}$$

$$\sqrt{D^2} = \sqrt{\frac{4A}{\pi}}$$

$$D = \sqrt{\frac{4(0,13)}{\pi}}$$

$$= 0,41 \text{ m or } 0,4075 \text{ m}$$

$$= 410 \text{ mm or } 407,5 \text{ mm}$$

√

√ (4)

**2.3 Gear Drive****2.3.1 Rotation of motor**

$$\begin{aligned}
 N_E &= \frac{80 \times 40 \times 90}{30 \times 20} \\
 &= \frac{288000}{600} && \checkmark \\
 &= 480 \text{ r/min} && \checkmark \quad (2)
 \end{aligned}$$

**2.3.2 Advantages**

- No slip occurs \
  - It is much stronger \
  - More accurate \
  - Last longer \
- (Any TWO correct answers)  $\checkmark$  (2)

**2.4 Belt Drive****2.4.1 Diameter of driven pulley**

$$\begin{aligned}
 D_{DN} &= \frac{N_{DR} \times D_{DR}}{N_{DN}} && \checkmark \\
 &= \frac{710 \times 420}{220} && \checkmark \\
 &= 1355,5 \text{ mm} && \checkmark \quad (3)
 \end{aligned}$$

**2.4.2 Width of belt**

$$\begin{aligned}
 \frac{T_1}{T_2} &= 2,5 && \checkmark \\
 \therefore T_1 &= 2,5T_2 && \checkmark \\
 \text{Power} &= \frac{(T_1 - T_2) \pi D n}{60} && \checkmark \\
 8 \times 10^3 &= \frac{(2,5T_2 - T_2) \times 0,42 \times 710}{60} && \checkmark \\
 \therefore T_2 &= 341,6 \text{ N} && \checkmark \\
 T_1 &= 2,5T_2 && \checkmark \\
 &= 2,5 \times 341,6 && \checkmark \\
 &= 854 \text{ N} && \checkmark \\
 \text{Tensile force is } &4 \text{ N per mm belt width.} && \\
 \therefore \text{Width} &= \frac{854}{4} && \checkmark \\
 &= 213,5 \text{ mm} && \checkmark \quad (6)
 \end{aligned}$$

**2.5 Gear Teeth**

- 2.5.1 Pitch circle diameter = Module x Number of teeth  
= 4 x 60  
= 240 mm √  
√ (2)
- 2.5.2 Addendum = Module  
= 4 mm √  
√ (2)
- 2.5.3 Clearance = 0,25 x module or 0,157 x module  
= 0,25 x 4 or 0,157 x 4  
= 1 mm or 0,628 mm √  
√ (2)
- 2.5.4 Dedendum = 1,25 x module or 0,157 x module  
= 1,25 x 4 or 1,157 x 4  
= 5 mm or 4,628 mm √  
√ (2)
- 2.5.5 Outside diameter = PCD + 2 module  
= 240 + 2(4)  
= 248 mm √  
√ (2)

**2.6 Square thread cutting tool**

- A** = Trailing/Following angle, **B** = Leading angle √√  
**C** = Clearance angle, **D** = Helix angle √√ (4)

**2.7 Clutches****2.7 Friction clutch**

$$T = \mu W n R$$

$$R = \frac{T}{\mu W n}$$
√

$$R = \frac{245}{0,35 \times 2500 \times 2}$$
√

$$R = \frac{245}{1750}$$

$$R = 0,14 \text{ m}$$
√

$$D = 2R$$

$$D = 2(0,14)$$
√

$$D = 0,28 \text{ m}$$

$$D = 280 \text{ mm}$$
√ (5)

**[50]**

**QUESTION 3: TOOLS AND EQUIPMENT****(Learning Outcome 3: Assessment Standard 2)****3.1 Brinell hardness tester**

- |    |                        |       |
|----|------------------------|-------|
| 1. | Test piece             | √     |
| 2. | Load                   | √     |
| 3. | Hardened steel ball    | √     |
| 4. | Diameter of impression | √ (4) |

**3.2 Tensile test**

- |   |       |
|---|-------|
| To determine,                                     | √     |
| the yield stress,                                 | √     |
| the ultimate tensile stress,                      | √     |
| the percentage elongation of a piece of material. | √ (4) |

**3.3 Wet compression test**

- |   |       |
|---|-------|
| • To determine worn rings   | √     |
| • To determine worn piston  | √     |
| • To check if there is a difference in readings between the dry test and the wet test | √     |
| • To verify if there is a need for performing the cylinder leakage test               | √ (4) |

3.4.1	Gas analyzer	√√ (2)
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3.4.2	Carbon Monoxide (CO) and Carbon Dioxide (CO <sub>2</sub> ) and water (H <sub>2</sub> O)	√√ (2)
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**3.5 Torsion**

Torsion is the <b>twisting action</b> in a member caused by <b>two opposing moments</b> along the <b>longitudinal axis of a member.</b>	√
	√ (2)

3.6	Is to investigate the deflection of the beam to see if the beam will withstand the required force (Testing for rigidity)	√√ (2)
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**[20]**

**QUESTION 4: MATERIALS****(Learning outcome 3: Assessment standard 3)****4.1 Tin snips**

4.1.1 High carbon steel or Tool steel √ (1)

4.1.2 

- They resist wear √
- It has high tensile strength √ (2)

4.1.3 

- To prevent rust √ (1)

**4.2 Ferrous alloys**

They are alloys that contain iron √

**examples**

- Low, medium and high carbon steels,
- stainless steel,
- chromium steel
- manganese steel
- vanadium steel
- titanium
- tungsten steel

(Any TWO correct answers) √  
√ (3)

**4.3 Hammer head**

4.3.1 Medium carbon steel √ (1)

4.3.2 

- Very tough √
- High tensile strength √ (2)

**4.4 Tensile definition**

The ability of a material to withstand pulling forces or tension forces √√ (2)

**4.5 Tensile strength**

**Material B** has the lowest tensile strength because it **deforms easily** √  
under tension or is the most deformed material. √ (2)



4.6 **Electric plug**

- 4.6.1 Nylon √
- It has resistance to wear √
  - It is a good insulator √
  - It has low frictional properties. (Any TWO correct answers) (2)

- 4.6.2 Bronze √
- Strong √
  - Tough √
  - Corrosion resistance √
  - Good conductor of electricity (Any TWO correct answers) (2)

4.7 **Properties of Carbon Fibre**

- Stiff and strong √
  - Low density √
  - Light weight √
  - Resistant to corrosion √
- (Any TWO: 1 x 2) (2)
- [20]**

**QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS****5.1 Torsion tester**

- Use safety goggles ✓
- Make sure the workpiece is properly tightened. ✓
- Be careful for metal particles coming off after the metal fractures. ✓
- Do not hold the test piece with your hands; it may be hot, use pliers. ✓ (4)

**5.2 MIG welder**

- The welding area must be kept clean and tidy. ✓
- Operator must use protective equipment ✓
- Make sure that the main cable insulation is not damaged when welding. ✓
- Gas bottle must be well secured with a chain ✓
- Welding area must have effective ventilation ✓
- Welding must not be carried out in areas of explosive and flammable liquids. ✓
- Use a fume extractor for toxic fumes given off when welding galvanized or zinc coated material (Any FOUR correct answers) ✓ (4)

**5.3 Helical cutter**

- Uses less power ✓
- Vibration experience by machine is less ✓
- Longer life span for the cutter ✓
- Deeper cuts may be taken ✓
- Wider cutters may be used (Any FOUR correct answers) ✓ (4)

**5.4 Dividing head**

To divide the circumference of a circular work into equally spaced dimension. ✓✓ (2)

5.5 Indexing

<b>Hole circles</b>											
Side 1	24	25	28	30	34	37	38	39	41	42	43
Side 2	46	47	49	51	53	54	57	58	59	62	66

<b>Standard change gears</b>										
24 x 2	28	32	40	44	48	56	64	72	86	100

5.5.1 Indexing

$$\begin{aligned}
 \text{Indexing} &= \frac{40}{n} = \frac{40}{160} && \checkmark \\
 &= \frac{1}{4} \times \frac{7}{7} \text{ or } \frac{1}{4} \times \frac{6}{6} && \checkmark \\
 &= \frac{7}{28} \text{ or } \frac{6}{24} && \checkmark
 \end{aligned}$$

7 holes on a 28-hole circle or 6 holes on a 24-hole circle  $\checkmark\checkmark$  (5)

5.5.2 Change gears

$$\begin{aligned}
 \frac{D_r}{D_v} &= (A - n) \times \frac{40}{A} \\
 &= (160 - 163) \times \frac{40}{160} && \checkmark \\
 &= \frac{-3 \times 40}{160} && \checkmark \\
 &= \frac{-120}{160} && \checkmark \\
 &= \frac{-3}{4} \times \frac{8}{8} && \checkmark \\
 &= \frac{-24}{32} && \checkmark
 \end{aligned}$$

Drive gear is 24 and the driven gear is 32  $\checkmark$  (5)

5.5.3 The index plate rotates in the opposite direction to the crank handle (-)

$\checkmark\checkmark$  (2)

**5.6 Cutting speed**

$V = \pi DN$	√
$N = \frac{V}{\pi D}$	√
$N = \frac{200}{\pi \times 0,2}$	√
$N = 318.31rpm$	
$f = f \times T \times N$	√
$f = 0,1 \times 20 \times 318.31$	√
$f = 636.62mm/min$	√
	(6)

**5.7 Dividing head**

- |                        |     |
|------------------------|-----|
| 1. Plunger             | √   |
| 2. Index plate         | √   |
| 3. 40-teeth worm wheel | √   |
| 4. Single start worm   | √   |
| 5. Sector arm          | √   |
|                        | (5) |

**5.8 Liquid/dye penetrate test**

- |  |     |
|--|-----|
| • Clean the surface to be tested.  | √   |
| • A liquid dye penetrant is sprayed onto the clean surface.  | √   |
| • Allow a short time for the dye to penetrate the welded joint.  | √   |
| • Remove the excess dye on the welded joint using a cloth.   | √   |
| • Wash the surface and allow it to dry thoroughly.   | √   |
| • Spray a developer on the surface which brings out the color in the dye penetrant, that has penetrated the cracks or pin holes. | √   |
| • Should the liquid dye come out of the welded joint, it means there are flaws in the joint.                                     | √   |
|  | (7) |

**5.9 Incomplete penetration**

Causes:

- |                               |     |
|-------------------------------|-----|
| • Current too low             | √   |
| • Electrode too large         | √   |
| • Joint preparation incorrect | √   |
| • Weld speed too fast         | √   |
| (Any THREE correct answers)   | (3) |

Cures/Prevention

- |                                   |     |
|-----------------------------------|-----|
| • Use correct current             | √   |
| • Proper electrode should be used | √   |
| • Joint should prepared properly  | √   |
| • Correct speed should be used    | √   |
| (Any THREE correct answers)       | (3) |

**[50]**

**QUESTION 6: MAINTENANCE AND TURBINES****(Learning Outcome 3: Assessment Standard 7 and 9)****6.1 Lubricating oil**

- 6.1.1 Label – timing chain
1. Timing chain √
  2. Camshaft pulley √
  3. Chain guide √
  4. Crankshaft pulley √
  5. Tensioner √ (5)
- 6.1.2 Needs of lubricating oil
- Viscosity must be correct. √
  - It must resist oxidation. √
  - It must prevent rust. √
  - It must avoid foaming. √
  - Resist carbon forming. √
  - It must prevent corrosion. √
  - It must resist extreme pressures (Any FOUR correct answers) √ (4)
- 6.1.3 Reasons for oil change
- Formation of gum, acids and lacquer may be left by the combustion of the fuel. √
  - Loses its viscosity after a while due to heat. √
  - Metal particles due to metal and metal contact √ (3)

**6.2 Oils**

- 6.2.1 SE - The letter 'S' Spark Ignition Engines √ (1)
- 6.2.2 CE - The letter 'C' Compression Ignition Engine √ (1)
- 6.2.3 SAE 20W50 - Society of Automotive Engineers. Multi grade oil √√ (2)
- 6.2.4 ATF - Automatic transmission fluid √ (1)

**6.3 Cutting fluid**

- Carry away the heat generated by machining process. √
- Acts as a lubricant. √
- Prevents the chips from sticking and fusing to the cutter teeth. √
- Improve quality of the finish of machined surface. √
- To obtain a higher cutting speed. √
- It gives the cutting tool a longer lifespan. √
- Does not rust the machine. (Any FOUR correct answers) √ (4)

**6.4 Properties of grease**

- It must be water resistant, it must not mix √
- Rust/corrosion resistant √
- Good for load pressure √
- High melting point √
- Low freezing point √ (Any THREE correct answers) √ (3)

**6.5 Superchargers****6.5.1 Purpose:**

- The supercharger fills the cylinder with an increased pressure that is higher than atmospheric pressure. √
  - The compression pressure in the cylinder is increased. √
  - The volumetric efficiency of the engine is increased. √
- (Any TWO correct answers) (2)

**6.5.2 Examples:**

- Used in racing cars. √
- Four-stroke Compression Ignition engines in heavy vehicles. √
- Earth moving equipment √
- Aircraft engine to overcome loss of power owing to height above sea level. √ (Any THREE correct answers) √ (3)

**6.5.3 Advantages:**

- More power is obtained compared to a similar vehicle without supercharger. √
  - Supercharged engines are more economical per given kilowatt output. √
  - Less fuel is used compared to engine mass. √
  - Power loss is eliminated above sea level √ (3)
- (Any THREE correct answers)

**6.6 Turbocharger**

- A turbocharger is driven by the exhaust gasses of the engine and therefore there is no power loss. √√
- The turbocharger is generally cheaper. (Any ONE correct answer) √√ (2)

**6.7 Steam turbines**

- It is compact √
- No lubrication is required √
- Steam turbine speed can be more accurately regulated √
- A variety of fuels can be used to obtain steam √
- More economical √ (Any THREE correct answers) √ (3)

**6.8 Gas turbines**

- Easy starting √
  - High power output from the given weight of engine √
  - No rubbing parts such piston so that internal friction and wear are almost eliminated. √
  - No water cooling system needed √
  - Requires little routine maintenance (Any THREE correct answers) √ (3)
- [40]**

**TOTAL: 200**