



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

MECHANICAL TECHNOLOGY

FEBRUARY/MARCH 2013

MEMORANDUM

MARKS: 200

This memorandum consists of 17 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

[20]

QUESTION 2: TOOLS AND EQUIPMENT

- 2.1 **Gas Analyzer**
CO (Carbon Monoxide) and hydrocarbon ✓ ✓ (2)
- 2.2 **Hardness** is the resistance against scratching, denting and wear. ✓ ✓ (2)
- 2.3 **Hardness testers:**
- Brinell hardness tester ✓
 - Rockwell hardness tester ✓
 - Vickers ✓
- (Any 2 x 1 = 2)** (2)
- 2.4 **Compression tester:**
- Check for worn cylinders ✓
 - Check for worn piston rings ✓
 - Check for worn pistons ✓
 - Check for inlet valve leakage ✓
 - Check for exhaust valve leakage ✓
 - Leaking cylinder head gasket ✓
- (Any 3 x 1=3)** (3)
- 2.5 **Cylinder leakage tester:**
- Listen at the carburettor for a hissing noise. ✓ Inlet valve is leaking. ✓
 - Listen at the exhaust pipe for a hissing noise. ✓ Exhaust valve is leaking. ✓
 - Listen for a hissing noise in the dipstick hole. ✓ Piston ring is worn. ✓
 - Listen for a hissing noise at the oil filler hole. ✓ Rings are worn ✓
 - Air bubbles in the radiator water. ✓ The cylinder head gasket is blown. ✓
- (Any 3 x 2=6)** (6)
- 2.6 **Tensile Tester**
A tensile tester measures the resistance of a material to a static or slowly applied tensile axial force. ✓ ✓ (2)
- 2.7 **Beam bending test**
Beam bending test is to investigate the deflection of beams. ✓
To see if the beam is safe enough to support the load. ✓ (2)
- 2.8 **MIGS – abbreviation:**
Metal Inert Gas Shielded ✓ (1)

[20]

QUESTION 3: MATERIALS**3.1 Reasons for manufacturing alloys:**

- Creating a harder, tougher metal ✓
 - Producing a stronger metal ✓
 - Increasing resistance to corrosion and rust ✓
 - Changing the colour of the metal ✓
 - Increasing or decreasing electrical resistance ✓
 - Improving ductility and elasticity ✓
 - Improving casting properties ✓
 - Strengthening the metal against wear and tear ✓
 - Lowering the cost of the metal ✓
 - Lowering the melting point to below the mean of the metal components ✓
- ✓ **(Any 3 x 1=3)** (3)

3.2 Advantages of thermoplastics:

- Thermoplastics lend themselves to rapid moulding and extrusion processes ✓
 - There is no wastage ✓
 - All scrap flashing and rejects can be used again ✓
- (Any 2 x 1=2)** (2)

3.3 Tin and lead bases in white metal:

- The tin-base white metal is used in heavy duty bearings to withstand greater pressures and speed ✓
 - Lead-based metals are used under less demanding conditions ✓
- (2)

3.4 Use of flux:

Flux is used to ensure that the solder flows over a chemically clean surface ✓ (1)

3.5 Advantages of silver solder:

- It has a higher melting point and variety of applications ✓
 - It is resistant to corrosion ✓
- (2)

3.6 Purpose of using certain materials:

- 3.6.1
- P.V.C. is not a good conductor of electricity and corrosion resistant ✓
 - It can be obtained in a range of colours and sizes ✓
- (2)
- 3.6.2
- Copper wire is used because it is a good conductor of electricity and will resist corrosion ✓
 - It is also very soft and malleable ✓
- (2)

3.7 **Reasons for working materials in liquid form:**

- Components can be made easily and cheaply without the need for expensive machine ✓
- Complex shapes can be made without the need of complicated machining processes ✓ (2)

3.8 **Nylon:**

3.8.1 **Properties of Nylon:**

- Needs no lubrication ✓
 - Can withstand shock ✓
 - Low maintenance ✓
 - Light in weight ✓
 - Easy to machine ✓
- (Any 2 x 1=2) (2)**

3.8.2 **Uses of Nylon**

- Fan blades ✓
 - Bearings ✓
 - Gears ✓
 - Trolley wheels ✓
 - Sliding plates ✓
 - Bolts and nuts ✓
- (Any 2 x 1=2) (2)**
[20]

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS**4.1 Tensile tester:**

- Use safety goggles to protect eyes ✓
- Do not apply excessive pressure ✓
- Work piece to be well secured for testing ✓
- Check the hydraulic fluid level ✓

(Any 3 x 1=3) (3)**4.2 Multi-meter:**

- Keep the meter dry ✓
- Keep the meter away from dust and dirt ✓
- Use and store the meter in normal temperature environment ✓
- Do not drop the meter ✓
- Use only charged cells of the correct size. ✓

(Any 3 x 1=3) (3)**4.3 Lathe:****4.3.1 Chuck:**

- Keep hands from rotating chuck ✓
- Don't leave the chuck key in the chuck ✓
- Make sure the chuck is well secured before switching on the machine ✓
- Place some protection on the bed while changing chucks ✓
- Turn the chuck by hand to be certain that there is no danger of the work piece striking any part of the lathe ✓
- Be careful not to run the cutting tool into the chuck ✓

(Any 1 x 1) (1)**4.3.2 Machine guard:**

- Make sure the guard is well secured before switching on the machine ✓
- Machine guard must be in a good condition ✓

(Any 1 x 1) (1)**4.3.3 Tail stock:**

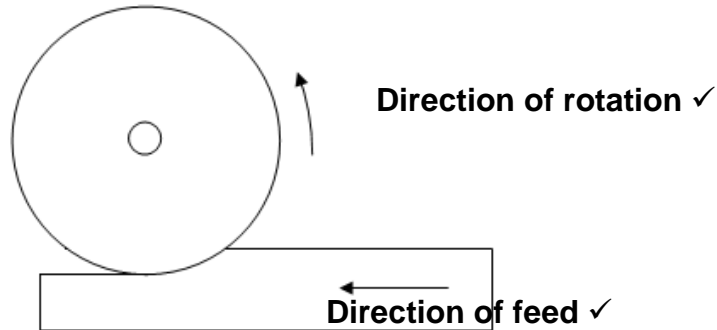
- Make sure the centre or drill chuck is well secured before switching on the machine ✓
- Make sure the tail stock is well secured and locked when cutting between centres ✓

(Any 1 x 1) (1)

4.4 **Indexing:**

4.4.1 Gear cutter or involute cutter ✓ (1)

4.4.2



(2)

4.4.3 **Indexing:**

$$\begin{aligned}
 \text{Indexing} &= \frac{40}{N} && \checkmark \\
 &= \frac{40}{100} && \checkmark \\
 &= \frac{2 \times 5}{5 \times 5} \\
 &= \frac{10}{25} \text{ or } \frac{12}{30} && \checkmark
 \end{aligned}$$

10 Holes on a 25 Hole circle ✓

(4)

4.4.4 **Change gears: (any of the other formulae are acceptable)**

$$\begin{aligned}
 \frac{D_r}{D_v} &= (N - n) \times \frac{40}{N} && \checkmark \\
 \frac{D_r}{D_v} &= (100 - 97) \times \frac{40}{100} && \checkmark \\
 &= \frac{120}{100} && \checkmark \\
 &= \frac{6 \times 8}{5 \times 8} && \checkmark \\
 &= \frac{48}{40} && \checkmark
 \end{aligned}$$

(5)

4.5 **Advantages of helical cutters:**

- Chattering is reduced ✓
- Helps to remove shavings ✓
- Continuous forming of shavings is prevented ✓
- Better cutting action ✓
- Finishing on the work piece is improved ✓
- Coolant flow is easier ✓

(Any 2x1 = 2) (2)

4.6 **Feed in mm/min:**

$$Feed = f_1 \times T \times N \quad \checkmark$$

$$Feed = 0,04 \times 30 \times 400 \quad \checkmark$$

$$= 480 \text{ mm/min} \quad \checkmark$$

(3)

4.7

4.7.1 **Dedendum:**

$$Dedendum = 1,25 \times m \quad \text{OR} \quad Dedendum = 1,157 \times m$$

$$Dedendum = 1,25 \times 2,5 \quad Dedendum = 1,157 \times 2,5 \quad \checkmark$$

$$= 3,125 \text{ mm} \quad = 2,89 \text{ mm} \quad \checkmark$$

(2)

4.7.2 **Gear ratio:**

$$Gear \text{ ratio} = \frac{\text{Product of number of teeth on the driven gears}}{\text{Product of number of teeth on the driving gears}}$$

$$Gear \text{ ratio} = \frac{50 \times 60}{25 \times 30} \quad \checkmark$$

$$Gear \text{ ratio} = 4 : 1 \quad \checkmark \quad (3)$$

4.7.3 **PCD:**

$$PCD = m \times T$$

$$= 2,5 \times 25 \quad \checkmark$$

$$= 62,5 \text{ mm} \quad \checkmark \quad (3)$$

4.7.4 **Outside diameter:**

$Outside\ Diameter = PCD + 2m$

$= 62,5 + 2 \times 2,5$ ✓

$= 67,5mm$ ✓

(2)

4.7.5 **Circular pitch:**

$Circular\ Pitch = \pi \times m$

$= \pi \times 2,5$ ✓

$= 7,85\ mm$ ✓

(3)

4.8 **Advantages of MIG/MAG:**

- Suitable for thin metals ✓
- Can weld continuously ✓
- Minimal post weld cleaning is required ✓
- Can weld in any position ✓

(Any 3x1=3)

(3)

4.9

WELDING FLAW	ONE CAUSE	NON – DESTRUCTIVE TEST
Cracks	<ul style="list-style-type: none"> • Rapid cooling ✓ • Base metal not weldable ✓ • Wrong weld technique. Weld too small ✓ <p style="text-align: right;">(Any 1x1)</p>	Liquid dye test ✓ Visual test ✓ (Any 1x1)
Poor fusion	<ul style="list-style-type: none"> • Current too low ✓ • Welding technique wrong ✓ • Joint preparation wrong. ✓ • Wrong electrode size ✓ <p style="text-align: right;">(Any 1x1)</p>	Visual test ✓
Porosity	<ul style="list-style-type: none"> • Atmospheric contamination ✓ • Surface contamination ✓ • Dirty or wet electrodes ✓ • Rusted MIG wire ✓ <p style="text-align: right;">(Any 1x1)</p>	X- ray test ✓
Undercutting	<ul style="list-style-type: none"> • Current too high ✓ • Wrong manipulation ✓ • Arc length too long ✓ • Welding speed too high ✓ <p style="text-align: right;">(Any 1x1)</p>	Visual test ✓

(2)

(2)

(2)

(2)

[50]

QUESTION 5: MAINTENANCE AND TURBINES

- 5.1 **Pour point** is the lowest temperature at which a liquid remains fluid or 'pourable' ✓✓ (2)
- 5.2 **Cutting fluids:**
- Avoid contamination of the cutting fluid by draining and regularly replacing it ✓
 - Always clean the machine's splash tray of metal cutting after use ✓
 - Regularly wipe clean fluid splashes of the machine parts (Only when machine is stationary) ✓
 - Ensure that the sump is topped up from time to time, and check that there is sufficient flow of cutting fluid to the cutting tool ✓
- (Any 3x1=3) (3)**
- 5.3 **Cutting fluids:**
- Acts as a lubricant ✓
 - Improve surface finish ✓
 - To keep the work piece cool ✓
 - To keep the cutting tool cool ✓
 - To obtain a higher cutting speed ✓
 - It gives the cutting tool a longer lifespan ✓
 - Prevent rust ✓
 - Wash away the chips ✓
- (Any 4x1=4) (4)**
- 5.4 **Changing engine oil:**
- Formation of gum, acids and lacquer may be left by the combustion of the fuel ✓
 - Oil loses its viscosity due to excessive heat ✓
 - Metal particles deposit in the oil due to metal on metal contact ✓
- (Any 2x1=2) (2)**
- 5.5 **Fitting oil filter:**
- Use a filter strap spanner and remove old oil filter ✓
 - Clean the filter area and lightly oil the mating surfaces ✓
 - Put a smear of clean engine oil on the seal of the filter ✓
 - Screw the filter into engine block ✓
 - Tighten filter by hand ✓
- (5)**

5.6 **Causes of bearing overheating:**

- Poor lubrication ✓
- Friction is increased due to dirty oil ✓
- Incorrect grade of oil ✓
- Misalignment of bearing and shaft causing undue strain ✓
- Shaft is out of round (oval) ✓
- Bearing not torqued according to specification, too tight ✓
- Load on bearing excessive ✓
- Uneven bearing surfaces ✓
- Poor assembly of bearing shells ✓

(Any 4x1=4) (4)

5.7 **Steam turbines:** are operated by using steam that creates kinetic energy to generate rotational motion that is mechanical energy ✓✓ (2)

5.8 **Classes of turbines:**

- Impulse turbine ✓
- Reaction turbine ✓

(2)

5.9 **Turbocharger:**

- The hot exhaust gases ✓
- are routed to the turbine wheel to enable the wheel to spin at very high speeds ✓
- The gases are then channelled out the housing and wheel assembly into the normal exhaust system ✓
- As the turbine wheel spins, it turns a common shaft, which in turn spins the impeller ✓
- The impeller and its housing acts as a compressor drawing air in through the inlet ✓
- and delivering it under pressure through the outlet into the cylinders which increases the volumetric efficiency ✓

(6)

5.10 **Advantages of gas turbines:**

- High power output from the given weight of engine ✓
- The torque output characteristic permits a simplification of the transmission system ✓
- Smooth vibration less running due to absence of reciprocating parts ✓
- No rubbing parts such as piston so that internal friction and wear are almost eliminated ✓
- Easy starting ✓
- Can use wide range of fuels ✓
- Low lubricating oil consumption ✓
- No water cooling system needed ✓
- Non-poisonous exhaust giving very little trouble with pollution ✓
- Requires little routine maintenance ✓

(Any 4x1=4)

(4)

5.11 **Boost** refers to the increase in manifold pressure that is generated by the turbocharger in the intake path that exceeds the normal atmospheric pressure ✓✓ (2)

5.12 **Advantages of a supercharger:**

- 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 ✓

(Any 2x1=2) (2)

5.13 **Disadvantages of a supercharger:**

- A small amount of power is lost in order to drive the supercharger because it uses the engine power to drive it ✓
- Higher fuel consumption results if the power generated is not fully used, as in the case of passenger vehicles ✓
- Owing to the compression of the air this results in an increase in temperature causing a decrease in the density of the inlet charge ✓
- The lifespan of the engine is decreased because of higher cylinder pressure, which increases the load on the engine components ✓

(Any 2x1=2) (2)
[40]

QUESTION 6 FORCES AND SYSTEMS AND CONTROL**6.1 Stress and Strain:**

6.1.1 Tensile stress ✓✓ (2)

6.1.2 Stress:

$$\begin{aligned}\sigma &= \frac{F}{A} && \checkmark \\ &= \frac{2,5 \times 10^3}{8,08 \times 10^{-3}} && \checkmark \\ &= 0,31 \times 10^6 \text{ Pa or } 309405,94 \text{ Pa} \\ &= 0,31 \text{ MPa} && \checkmark\end{aligned}$$

(3)

6.1.3 Strain:

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L} && \checkmark \\ &= \frac{0,391 \times 10^{-3}}{3,08} && \checkmark \\ &= 0,13 \times 10^{-3} \text{ or } 0,00012694 && \checkmark\end{aligned}$$

(3)

6.1.4 Elasticity modulus:

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} && \checkmark \\ &= \frac{0,31 \times 10^6}{0,13 \times 10^{-3}} && \checkmark \\ &= 2,38 \times 10^9 \text{ or } 2437265184 \text{ Pa} && \checkmark \\ &= 2,44 \text{ GPa} && \checkmark\end{aligned}$$

(3)

6.2 **Gear drives:**6.2.1 **Number of teeth on driven gear:**

$$\begin{aligned}
 N_B T_B &= N_A T_A && \checkmark \\
 T_B &= \frac{N_A T_A}{N_B} && \checkmark \\
 &= \frac{660 \times 50}{1000} && \checkmark \\
 &= 33 \text{ teeth} && \checkmark
 \end{aligned}
 \tag{4}$$

6.2.2 **Rotation frequency of the driven gear:**

$$\begin{aligned}
 N_C T_C &= N_A T_A && \checkmark \\
 N_C &= \frac{N_A T_A}{T_C} && \checkmark \\
 &= \frac{660 \times 50}{60} && \checkmark \\
 &= 550 \text{ rpm} && \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 N_B T_B &= N_C T_C && \checkmark \\
 N_C &= \frac{N_B T_B}{T_C} && \checkmark \\
 &= \frac{1000 \times 33}{60} && \checkmark \\
 &= 550 \text{ rpm} && \checkmark
 \end{aligned}
 \tag{4}$$

6.2.3 **Clockwise** ✓✓ (2)

6.3 **Belt drives:**6.3.1 **Diameter driven pulley:**

$$\begin{aligned}
 N_{DV} D_{DV} &= N_{DR} D_{DR} && \checkmark \\
 D_{DV} &= \frac{N_{DR} D_{DR}}{N_{DV}} && \checkmark \\
 &= \frac{7,2 \times 600}{10} && \checkmark \\
 &= 432 \text{ mm} && \checkmark
 \end{aligned}
 \tag{4}$$

6.3.2 **Power transmitted:**

$$\begin{aligned}
 \frac{T_1}{T_2} &= 2,5 && \text{—————} \checkmark \\
 T_2 &= \frac{T_1}{2,5} && \text{—————} \checkmark \\
 &= \frac{300}{2,5} && \\
 &= 120 \text{ N} && \text{—————} \checkmark \\
 \\
 P &= (T_1 - T_2) \times \pi \times D \times n && \text{—————} \checkmark \\
 &= (300 - 120) \times \pi \times 0,6 \times 7,2 && \text{——} \checkmark \\
 &= 2\,442,90 \text{ Watt} && \\
 &= 2,44 \text{ kW} && \text{—————} \checkmark
 \end{aligned}
 \tag{6}$$

6.4 **Hydraulics:**6.4.1 **Pressure:**

$$\begin{aligned}
 A_A &= \frac{\pi D^2}{4} && \checkmark \\
 &= \frac{\pi(0,036)^2}{4} \\
 &= 1,02 \times 10^{-3} \text{ m}^2 \text{ or } 0,001017876 \text{ m}^2 && \checkmark
 \end{aligned}$$

$$\begin{aligned}
 P &= \frac{F_A}{A_A} && \checkmark \\
 &= \frac{0,85 \times 10^3}{1,02 \times 10^{-3}} = 835072,23 \text{ Pa} && \checkmark \\
 &= 0,83 \text{ MPa} && \checkmark
 \end{aligned}$$

(5)

6.4.2 **Number of strokes:**

$$\begin{aligned}
 A_B &= \frac{\pi D^2}{4} && \checkmark \\
 &= \frac{\pi(0,225)^2}{4} \\
 &= 39,76 \times 10^{-3} \text{ m}^2 \text{ or } 0,039760782 \text{ m}^2 && \checkmark
 \end{aligned}$$

$$\begin{aligned}
 V_A &= V_B && \checkmark \\
 A_A \times L_A &= A_B \times L_B \\
 L_A &= \frac{A_B \times L_B}{A_A} && \checkmark \\
 &= \frac{39,76 \times 10^{-3} \times 33,86 \times 10^{-3}}{1,02 \times 10^{-3}} && \checkmark \\
 &= 1,32 \text{ m or } 1,322656 \text{ m} && \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Number of strokes by A} &= \frac{L_A}{\text{One stroke length}} && \checkmark \\
 &= \frac{1,32}{0,11} && \checkmark \\
 &= 12 \text{ strokes} && \checkmark
 \end{aligned}$$

(9)

6.5 **Effective diameter:**

$$T = \mu W n R \quad \text{_____} \quad \checkmark$$

$$R = \frac{T}{\mu W n} \quad \text{_____} \quad \checkmark$$

$$= \frac{220}{0,4 \times 2,8 \times 10^3 \times 2} \quad \text{_____} \quad \checkmark$$

$$= 0,098 \text{ m or } 0,098214285 \text{ m}$$

$$\text{Eff diameter} = R \times 2 \quad \text{_____} \quad \checkmark$$

$$= 0,098 \times 2 \quad \text{_____}$$

$$= 0,2 \text{ m or } 0.196428571 \text{ m}$$

$$= 200 \text{ mm} \quad \text{_____} \quad \checkmark$$

(5)
[50]**TOTAL: 200**