



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY

FEBRUARY/MARCH 2014

MEMORANDUM

MARKS: 200

This memorandum consists of 16 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

[20]

QUESTION 2: TOOLS AND EQUIPMENT**2.1 Procedure for compression testing:**

- Run the engine until it reaches normal operating temperature. ✓
- Remove the high-tension leads and take out the spark plugs to disable the ignition system. ✓
- Disconnect the fuel supply to the cylinders. ✓
- Screw the gauge into cylinder one's spark plug hole and rest it where you can see the dial while you crank the engine. ✓
- Fully open the throttle. ✓
- Crank the engine until the dial stops rising. (± 10 revolutions) ✓
- Write down the final reading and reset the gauge to '0'. ✓
- Repeat the procedure on all the cylinders and compare the reading with the manufacturer manual. ✓ (8)

2.2 Testing of materials:

2.2.1 Bending test: It is used to determine the ductility or toughness of a material ✓✓ (2)

2.2.2 Tensile test: It is used to determine the tensile strength of a material ✓✓ (2)

2.3 Multimeter:

To measure:

- DC current ,
- DC voltage ,
- AC voltage ,
- Resistance ,
- Temperature ,
- Transistor ,
- Diode ,
- Battery ,

ANY 4 x 1 (4)

2.4 Brinell hardness tester:

- A - Applied force ✓
- B - Ball ✓
- C - Work piece ✓
- D - Indentation ✓ (4)

[20]

QUESTION 3: MATERIALS**3.1 Hammer head:****3.1.1 Type of material:**

Medium carbon steel ✓ (1)

3.1.2 Properties:

- stronger than low carbon steel ✓
- not as ductile as low carbon steel ✓
- Less brittle than high carbon steel ✓

ANY 2 x 1 (2)

3.1.3 Heat Treatment:

With heat treatment it becomes tougher and harder ✓✓ (2)

3.2 Greenhouse frame:**3.2.1 Properties:**

- corrosion resistant ✓
- strong ✓
- good appearance ✓

(3)

3.2.2 Advantages over a solid bar:

- light in weight ✓
- cheaper ✓

(2)

3.2.3 It will rust easily and is not as strong ✓✓ (2)

3.3 Electrical three pin plug:**3.3.1 Material for Pin:**

Copper/Brass. ✓

Reasons:

- good conductor of electricity ✓
- corrosion resistant ✓

(3)

3.3.2 Casing:

Nylon/PVC✓

ANY 1X1**Reasons:**

- good insulator ✓
- cheap to manufacture ✓
- good impact resistance ✓
- resistance to natural elements such as sun, cold and heat ✓

ANY 2x1**(3)****3.4 Properties of carbon fibre:**

- light in weight
- resistant to corrosion
- strong
- low density

✓
✓
✓
✓**ANY 2 x1****(2)****[20]**

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS**4.1 Milling machine:**

- select the correct tool for the job ✓
- make sure that all guards are in place ✓
- make sure that there is no oil and grease on the floor around the machine ✓
- tools must never be left on moving parts ✓
- work pieces and holding devices must be firmly clamped ✓
- use a wire hook or brush to remove cuttings ✓
- never adjust the cutting tool while the machine is running ✓
- do not lean on the machine ✓

ANY 4 x1 (4)**4.2 Spring compressors:**

- Do not use wire or rope to compress the coil spring, use spring compressors ✓
- Ensure that the equipment is absolutely safe ✓
- Make sure that the compressors are well in place before compressing the coil spring by turning the bolts ✓
- Compressing and releasing the coil springs must take place slowly and evenly ✓

ANY 2 x1 (2)**4.3 MIGS/MAGS welding:**

- Always wear the correct personal protective clothes ✓
- Make sure that the welding area is well ventilated ✓
- Ensure there are no fire hazards in the workshop and that adequate fire protection is in place ✓
- Ascertain that equipment is safe before being used ✓

ANY 3 x1 (3)**4.4 Indexing:****Indexing for 17 teeth:**

$$\text{Indexing} = \frac{40}{n} \quad \checkmark$$

$$= \frac{40}{17} \quad \checkmark$$

$$= 2 \frac{6}{17} \times \frac{2}{2} \quad \checkmark$$

$$= 2 \frac{12}{34} \quad \checkmark$$

2 full turns 12 holes on a 34 hole circle ✓

or 2 full turns 18 holes on a 51 hole circle

(5)

4.5 Indexing:**4.5.1 Indexing required:**

$$\begin{aligned}
 \text{Indexing} &= \frac{40}{N} && \checkmark \\
 &= \frac{40}{90} && \checkmark \\
 &= \frac{4}{9} \times \frac{6}{6} && \checkmark \\
 &= \frac{24}{54} && \checkmark
 \end{aligned}$$

Indexing = 0 full turns and 24 holes on a 54 hole circle \checkmark (5)

4.5.2 Change gears required:

$$\begin{aligned}
 \text{Change gears} &= (N - n) \times \frac{40}{N} && \checkmark \\
 &= (90 - 91) \times \frac{40}{90} && \checkmark \\
 &= -\frac{4}{9} && \checkmark \\
 &= \frac{4}{9} \times \frac{8}{8} = \frac{32}{72} && \checkmark \\
 \frac{\text{Driver}}{\text{Driven}} &= \frac{32}{72} && \checkmark
 \end{aligned}$$

(6)

4.6 MIGS/MAGS Welding process:

A - Gas shroud	\checkmark	
B - Nozzle	\checkmark	
C - Wire feed	\checkmark	
D - Arc	\checkmark	
E - Inert shielded gas	\checkmark	
F - Parent metal	\checkmark	
G - Molten weld pool	\checkmark	(7)

4.7 Uses of cutters:

- 4.7.1 T-slot milling cutters are designed for cutting T-slots in machine tables and similar applications. (1)
- 4.7.2 End mill cutters are used for machining slots, keyways, pockets, facing narrow faces and cutting profiles (1)
- 4.7.3 Slitting saw cutters are used for parting off and slitting thin sections and the cutting of deep and narrow slots (1)
- 4.7.4 Form ('Profile') cutters are used for producing hollows, corner-rounded edges, gears, formed tooth and threads (1)

4.8 Welded Joints:**4.8.1 Porosity causes:**

- Surface contamination ✓
 - Rusted MIG wire ✓
 - Atmospheric contamination ✓
 - Dirty or wet electrodes ✓
- ANY 2x1** (2)

Porosity preventions:

- Clean the surface ✓
 - Use the correct electrode ✓
 - Check for impurities in base metal ✓
- ANY 1x1** (1)

4.8.2 Slag inclusion preventions:

- By chipping off the slag from the previous weld runs ✓
 - Brushing the weld bead with a wire brush before further welding ✓
 - Use the correct current setting ✓
 - Increase the included angle ✓
- ANY 2x1** (2)

4.8.3 Distortion:

The twisting of a metal out of shape due to uncontrolled expansion and contraction forces due to weld heat ✓✓ (2)

4.8.4 Arc welding:

- Rate of the electrode burning and the progress of the weld ✓
- Amount of penetration and fusion ✓
- The way the weld metal is flowing ✓
- The sound of the arc, indicating the correct current and voltage for the particular weld ✓

ANY 3x1 (3)**4.8.5 MIG/MAGS:**

- Can weld in any position ✓
- Higher deposition rate ✓
- Less operator skill required ✓
- Long welds can be made without stops and starts ✓
- Minimal post weld cleaning is required ✓

ANY 4x1 (4)
[50]

QUESTION 5: MAINTENANCE AND TURBINES**5.1 Reasons for bearing failure:**

- Insufficient lubrication ✓
- Excessive lubrication ✓
- Grease flowing ✓
- Foaming oil ✓
- Corrosive contaminants in bearing ✓
- Raceway turning on shaft or in housing ✓
- Inadequate bearing clearances caused by being too tight on shaft or on housing ✓
- Excessive clearance ✓
- Contamination/dirt ✓

ANY 4 X 1 (4)**5.2 Importance of oil seal:**

- Oil seals are fitted to ensure that there are no oil leaks as different parts of an engine are being lubricated ✓✓ (2)

5.3 Oil terms:

- Corrosion resistance is the ability of oil to displace water from the metal allowing the oil to coat the surfaces ✓
- Rust resistance also has the alkaline reaction to neutralize combustion acid thus preventing corrosion ✓ (2)

5.4 Cutting fluids:

- Carry away the heat generated by machining process ✓
- Acts as a lubricant ✓
- Prevents the chips from sticking and fusing to the cutter teeth ✓
- Improves quality of the finish of the surface ✓
- To keep the work piece and the cutting tool cool ✓
- To obtain a high cutting speed ✓
- It gives a cutting tool a longer lifespan ✓

ANY 4 X 1 (4)

5.5 Gearbox oil change:

- Draining must be done at normal working temperature. ✓
- Locate the filler plug on the side of the gearbox casing and wipe the plug and area around it clean. Place tray under the gearbox. ✓
- Remove the filler plug. ✓
- Remove the drain plug using a well-fitting spanner in the base of the gearbox. ✓
- Allow oil to drain out of the gearbox into the drain pan. ✓
- Clean the drain plug and make sure to fit a new sealing washer. ✓
- Replace the drain plug and make sure it is tight. ✓
- Refill the gearbox with the recommended oil to the base of the filler plug and allow excess oil to trickle out and refit the filler plug. ✓ (8)

5.6 Blower:

5.6.1 Vane type blower ✓ (1)

5.6.2 Labels of a blower:

- | | | |
|-------------|---|-----|
| A - Vane | ✓ | |
| B - Inlet | ✓ | |
| C - Rotor | ✓ | |
| D - Housing | ✓ | |
| E - Outlet | ✓ | (5) |

5.6.3 Operation of a blower:

- Engine drives the rotor by means of a belt drive ✓
- Thus creating a vacuum when air is taken in through the inlet port ✓
- The air is then carried between the vanes and the housing to the outlet port ✓
- As a result of the eccentric mounting of the rotor, the space is reduced and air is pushed out under pressure ✓
- This air is forced through the inlet manifold into the cylinders ✓ (5)

5.7 Difference between turbo and supercharger:

- Turbocharger is driven by the exhaust gases of the engine ✓
- Supercharger is mechanical driven by using the engine power ✓ (2)

5.8 Advantage of supercharger:

- Increases the output power of the engine ✓
- A smaller engine fitted with a centrifugal blower delivers the same power as a larger engine ✓
- It eliminates lack of oxygen above sea level ✓
- Increases the volumetric efficiency of the engine ✓
- With the aid of the intercooler both the power and the torque output of the engine are increased ✓

ANY 3 X 1 (3)**5.9 Advantages of steam turbines:**

- It is compact ✓
- No lubrication is required ✓
- Steam turbine speeds can be more accurately regulated ✓
- A variety of fuels can be used to obtain steam ✓
- Steam turbines are more economical ✓
- Higher speeds can be obtained as compared to internal combustion engine ✓
- Convert heat energy into mechanical energy ✓

ANY 3 X 1 (3)**5.10 Disadvantage of steam turbine:**

- Needs a large area for fuel storage ✓
- Cooling towers are used to regulate steam to reduce the usage of water ✓

ANY 1 X 1 (1)**[40]**

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

6.1.1 Compressive stress ✓ (1)

6.1.2 Stress:

$$\begin{aligned}\sigma &= \frac{F}{A} && \checkmark \\ &= \frac{3 \times 10^3}{10,08 \times 10^{-3}} && \checkmark \\ &= 0,298 \times 10^6 \text{ Pa} && \checkmark \\ &= 0,298 \text{ MPa} && \checkmark\end{aligned}$$

(4)

6.1.3 Strain:

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L} && \checkmark \\ &= \frac{0,5 \times 10^{-3}}{3,5} && \checkmark \\ &= 0,143 \times 10^{-3} && \checkmark\end{aligned}$$

(3)

6.1.4 Elasticity modulus:

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} && \checkmark \\ &= \frac{0,298 \times 10^6}{0,143 \times 10^{-3}} && \checkmark \\ &= 2,08 \times 10^9 && \\ &= 2,08 \text{ GPa} && \checkmark\end{aligned}$$

(3)

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

$$\begin{aligned}N_B \times T_B &= N_A \times T_A && \checkmark \\ T_B &= \frac{N_A \times T_A}{N_B} && \checkmark \\ &= \frac{700 \times 56}{980} && \checkmark \\ &= 40 \text{ teeth} && \checkmark\end{aligned}$$

(4)

6.2.2 Rotation frequency of the driven gear:

$$N_C \times T_C = N_A \times T_A \quad \checkmark$$

$$N_C = \frac{N_A \times T_A}{T_C} \quad \checkmark$$

$$= \frac{700 \times 56}{64} \quad \checkmark$$

$$= 612.5 \text{ rpm} \quad \checkmark$$

(4)

6.2.3 Anti-clockwise ✓✓

(2)

6.3 Belt drives:**6.3.1 Diameter of the pulley that needs to be fitted onto the machine:**

$$N_{dn} \times D_{dn} = N_{dr} \times D_{dr} \quad \checkmark$$

$$D_{dn} = \frac{N_{dr} \times D_{dr}}{N_{dn}} \quad \checkmark$$

$$= \frac{9,4 \times 640}{15} \quad \checkmark$$

$$= 401,07 \text{ mm} \quad \checkmark$$

$$= 400 \text{ mm} \quad \checkmark$$

(4)

6.3.2 Power transmitted:

$$\frac{T_1}{T_2} = 2,5 \quad \checkmark$$

$$T_2 = \frac{T_1}{2,5} \quad \checkmark$$

$$T_2 = \frac{320}{2,5} \quad \checkmark$$

$$= 128 \text{ N} \quad \checkmark$$

but

$$\text{Power} = (T_1 - T_2) \times \pi \times DN \quad \checkmark$$

$$= (320 - 128) \times \pi \times 0,64 \times 9,4$$

$$= 192 \times \pi \times 0,64 \times 9,4 \quad \checkmark$$

$$= 3628,76 \text{ Watt} \quad \checkmark$$

$$= 3,628 \text{ kW} \quad \checkmark$$

(6)

6.4 Hydraulics:**6.4.1 Pressure:**

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

$$= \frac{\pi(0,04)^2}{4} \quad \checkmark$$

$$A_A = 1,257 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$P = \frac{F_A}{A_A} \quad \checkmark$$

$$= \frac{0,9 \times 10^3}{1,257 \times 10^{-3}} \quad \checkmark$$

$$= 715990,45 \text{ Pa}$$

$$= 715,990 \text{ kPa} \quad \checkmark$$

(5)

6.4.2 Number of strokes:

The volume of the system stays the same

$$A_B = \frac{\pi D^2}{4} \quad \checkmark$$

$$= \frac{\pi(0,240)^2}{4}$$

$$= 45,24 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

Volume displayed by A = Volume displayed by B

$$V_A = V_B \quad \checkmark$$

$$A_A \times L_A = A_B \times L_B$$

$$L_A = \frac{A_B \times L_B}{A_A} \quad \checkmark$$

$$= \frac{(45,24 \times 10^{-3})(35 \times 10^{-3})}{1,257 \times 10^{-3}} \quad \checkmark$$

$$= 1,26 \text{ m} \quad \checkmark$$

$$\text{Number of strokes by piston A} = \frac{L_A}{\text{One stroke length}} \quad \checkmark$$

$$= \frac{1,26}{0,126} \quad \checkmark$$

$$= 10 \text{ strokes} \quad \checkmark$$

(9)

6.5 **Clutch:****Effective diameter:**

$$T = \mu W n R \quad \checkmark$$

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

$$R = \frac{240}{0,6 \times 3,4 \times 10^3 \times 2} \quad \checkmark$$

$$R = 0,059 \text{ m}$$

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

$$D = 0,059 \times 2$$

$$D = 0,118 \text{ m} \quad \checkmark$$

$$= 118 \text{ mm}$$

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