



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY
NOVEMBER 2011
MEMORANDUM

MARKS: 200

DEPARTMENT OF BASIC
EDUCATION
2011 -11- 10
PRIVATE BAG X 110
PRETORIA 0001
PUBLIC EXAMINATIONS

This memorandum consists of 16 pages.

Approved.
[Signature]
I.M
14.11.11

[Signature]
M.P. FODLEY
14.11.2011
UMALUSI

Approved
[Signature]
Please turn over

ANSWER SHEET**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

1.1	A	B	C	D
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1.2	A	B	C	D
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1.3	A	B	C	D
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1.4	A	B	C	D
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1.5	A	B	C	D
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1.6	A	B	C	D
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1.7	A	B	C	D
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1.8	A	B	C	D
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1.9	A	B	C	D
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1.10	A	B	C	D
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1.11	A	B	C	D
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1.12	A	B	C	D
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1.13	A	B	C	D
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1.14	A	B	C	D
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1.15	A	B	C	D
------	---	---	---	---

1.16	A	B	C	D
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1.17	A	B	C	D
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1.18	A	B	C	D
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1.19	A	B	C	D
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1.20	A	B	C	D
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[20]

QUESTION 2: TOOLS AND EQUIPMENT**2.1 Cylinder leakage test:**

2.1.1 Cylinder Leakage Test ✓ (1)

2.1.2 Procedure for cylinder leakage test:

- Run the engine until normal operating temperature. ✓
- Remove the spark plug from cylinder number three ✓
- Install cylinder leakage tester to the spark plug hole of cylinder number three. ✓
- Remove the oil filler cap, radiator filler cap as well as the air filter. ✓
- Turn the crankshaft pulley until piston number three is at TDC (Power stroke) ✓
- Apply air pressure to cylinder. ✓
- 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 at the dipstick for a hissing noise. (Piston rings are worn) ✓
- Listen at the oil filler hole for a hissing noise. (Piston rings are worn) ✓
- Look for bubbles in the radiator water, if so the cylinder head gasket is blown or the cylinder block is cracked. ✓ (11)

[50% (6 marks) will be credited for the steps related to any type of test other than that mentioned in 2.1.1]

2.2 Spring tester:

- Squareness/Roundness ✓ or (specifications of length and pressure) (2)
- Correct tension ✓

2.3 Computer Numerical Control ✓ (1)

2.4 Metal arc gas shielded:**2.4.1 Advantages**

- Can weld in any position. ✓
- Higher disposition rate. ✓
- Less operator skill required. ✓
- Long welds can be made without stops and starts. ✓
- Minimal post-weld cleaning / no slag removal is required. ✓
- Causes less deformation ✓
- Gives better finish ✓
- Faster than arc welding ✓ (3)

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- Easy operation ✓ **Any 3 X 1**

2.4.2

Gasses

- Argon ✓ and CO₂ ✓

(2)
[20]

QUESTION 3: MATERIALS**3.1 Carbon fibre:**

- It gives a smooth finish ✓
- Light in weight ✓
- Resistant to corrosion ✓
- Easy to mould ✓
- Its tough ✓
- It's strong ✓

Any 2 X 1 (2)**3.2 Stiffness of materials:**

Material B is the stiffer ✓

Reason: Material B is more resistant to a bending deformation ✓✓

(3)**3.3 Non-ferrous alloys:**

3.3.1 A non-ferrous alloy is a metal that has a combination of two or more non-ferrous metals. ✓✓

(2)**3.3.2 Examples:**

- Brass ✓
- Bronze ✓
- White metal ✓
- Duralumin ✓
- Solder ✓
- Silver solder ✓

Any 3 X 1 (3)**3.4 Composite:****3.4.1 Thermosetting plastics**

- Teflon ✓
- Nylon ✓

(2)**3.4.2 Properties of Teflon and nylon to support choice:**

- High friction resistance ✓
- Light in weight ✓
- Easy to work with ✓
- Provides a smooth finish ✓
- Needs no lubrication ✓
- No/low maintenance ✓
- Corrosion free ✓
- Poor conductor of electricity ✓ **Any 4 X 1**

(4)**3.5 Soft solder**

Lead ✓ and tin ✓ or Antimony

(2)**3.6 Silver solder**

High melting point ✓

Resistant to corrosion ✓

(2)

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good conductor
give a strong bead
used to join a variety of materials

[20]

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS**4.1 Hydraulic press:**

- Make sure the object is firmly secured. ✓
- Make sure pins holding the beam is fitted properly. ✓
- Check pins for wear. ✓
- Check for oil leaks. ✓
- Make sure the area around the press is clean and free from oil. ✓
- Release pressure after operation ✓
- Personal safety ✓
- Safety guards ✓

(4)

Any 4 X 1

4.2 Gas cylinders:

- Store oxygen and acetylene separately. ✓
- Store full and empty cylinders apart. ✓
- Keep cylinders in a cool place away from heat. ✓
- Place cylinders in an upright position. ✓
- Don't drop cylinders. ✓
- Cylinder heads must be on. ✓
- Keep cylinders away from oil or grease. ✓
- Don't hammer on cylinders. ✓
- Secure cylinders properly. ✓
- Do not transport in horizontal position ✓

Any 4 X 1 (4)

4.3 Cutting feed:

$$V = \pi DN$$

$$N = \frac{V}{\pi D} \quad \checkmark$$

$$N = \frac{100}{\pi \times 0,12} \quad \checkmark$$

$$N = 265,2582385 \text{ rpm} \quad \checkmark$$

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

$$f = 0,1 \times 40 \times 265,258 \quad \checkmark$$

$$f = 1061,03 \text{ mm/min} \quad \checkmark$$

(6)

4.4 Indexing:

4.4.1

$$\begin{aligned} \text{Indexing} &= \frac{40}{A} && \checkmark \\ &= \frac{40}{70} && \checkmark \\ &= \frac{4 \times 4}{7 \times 4} \text{ or } \frac{4 \times 6}{7 \times 6} \text{ or } \frac{4}{7} && \checkmark \\ &= \frac{16}{28} \text{ or } \frac{24}{42} \text{ or } \frac{28}{49} && \checkmark \end{aligned}$$

16 holes on the 28 – hole cir ✓

24 holes on the 42 - hole cir

28 holes on the 49 - hole cir ✓

(5)

4.4.2

$$\frac{D_r}{D_v} = (A-n) \times \frac{40}{A} \quad \checkmark$$

$$\frac{D_r}{D_v} = (70-67) \times \frac{40}{70} \quad \checkmark$$

$$\frac{D_r}{D_v} = \frac{120}{70} \quad \checkmark$$

$$\frac{D_r}{D_v} = \frac{12 \times 4}{7 \times 4} \quad \checkmark$$

$$\frac{D_r}{D_v} = \frac{48}{28} \quad \checkmark$$

No full turn, 16 holes on the 28-hole circle ✓

with change gears $\frac{48}{28}$ or

No full turn, 24 holes on the 42-hole circle

with change gears $\frac{48}{28}$ or

No full turn, 28 holes on the 49-hole circle

with change gears $\frac{48}{28}$

(5)

4.4.3 Same direction/clockwise/positive ✓

(1)

4.5 **Gear drives:**

4.5.1 Driving gear /electrical motor gear✓ (1)

4.5.2 Clockwise direction✓ (1)

4.5.3 Output/final/driven gear/ washing machine gear✓ (1)

4.5.4 **Gear B**

$$N_A \times T_A = N_B \times T_B \quad \checkmark$$

$$1200 \times 30 = N_D \times 22 \quad \checkmark$$

$$N_B = 1636 \text{ rpm} \quad \checkmark$$

(3)

4.5.5 **Gear A**

$$PCD = m \times T$$

$$= 3 \times 30 \quad \checkmark$$

$$= 90 \text{ mm} \quad \checkmark$$

(2)

4.5.6 **Outside diameter**

$$\text{Outside diameter (OD)} = PCD + 2 \times \text{Module}$$

$$= 90 + (2 \times 3) \quad \checkmark$$

$$= 96 \text{ mm} \quad \checkmark$$

(2)

4.5.7 **Dedendum**

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

$$= 1,157 \times 3$$

$$= 3,471 \text{ mm} \quad \checkmark$$

OR

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

$$= 1,25 \times 3$$

$$= 3,75 \text{ mm} \quad \checkmark$$

(2)

4.6 **Weld defects and testing:**4.6.1 **Causes porous weld:**

- Atmospheric contamination. ✓
- Surface contamination. ✓
- Dirty or wet electrodes. ✓
- Rusted MIG wire. ✓
- Type of welder ✓
- Current too high ✓
- Poor quality material ✓
- Incorrect method ✓
- Dirty welding rods ✓

Any 2 X 1 (2)

- 4.6.2 **Prevention:**
- Clean the workpiece. ✓
 - Use clean, dry electrodes. ✓
 - Use correct electrodes including low hydrogen electrodes ✓
- Any 1 X 1** (1)
- 4.6.3 **Causes of poor fusion:**
- Welding current too low or too fast. ✓
 - Welding pool too wide or too large ✓
 - Wrong joint preparation (root gap & chamfering). ✓
 - Welding electrode too thick. ✓
- Any 2 X 1** (2)
- 4.6.4 **Prevention:**
- Use correct current. ✓
 - Be sure to melt the sides of the groove. ✓
 - Groove must be free of other metals. ✓
 - Width of the electrode must be small enough to fit in groove. ✓
- Any 1 X 1** (1)
- 4.6.5 **Liquid dye penetration test:**
- Clean the weld that needs to be tested. ✓
 - The dye is sprayed onto the welded surface. ✓
 - Allowed dye to penetrate all the cracks. ✓
 - Excess dye is cleaned away with a cleaning agent. ✓
 - Allowed surface to dry. ✓
 - Spray a developer onto the surface to bring out the dye trapped in cracks. ✓
 - The dye will show all the surface defects ✓

(7)
[50]

QUESTION 5: MAINTENANCE AND TURBINES**5.1 Lubrication:****5.1.1 Properties**

- Viscosity must be correct. ✓
 - It must resist oxidation. ✓
 - It must avoid foaming. ✓
 - Resist carbon forming. ✓
 - It must prevent corrosion or rust. ✓
 - It must resist extreme pressures. ✓
 - Pour point ✓
 - Resistance to temperature change ✓
- Any 5 X 1 (5)**

5.1.2 Viscosity of oil refers to the resistance of oil to flow./ thickness of oil ✓✓ (2)

5.1.3 EP Oils

- Manual gearbox ✓
 - Final drive or differential ✓
 - Heavy duty machinery
- Any 2 X 1 (2)**

5.1.4 Society of Automotive Engineers ✓ (1)

5.1.5 Cutting Fluid

- Acts as lubricant ✓
 - Prevents chips from sticking ✓
 - Improves quality of finish ✓
 - Keeps the work piece cool ✓
 - Keeps the cutting tool cool ✓
 - Gives the cutting tool a longer life span ✓
 - Wash away/remove chips/swarfs
- Any 4 x 1 (4)**

5.1.6 Gear Lubrication

COLUMN A	COLUMN B
Engine	SAE 20W50
Gearbox	Extreme pressure oil (EP 90)
Differential	Extreme pressure oil (EP 90)
Power steering	Hydraulic oil

B✓
D✓
D✓
A✓ (4)

5.1.7 Automatic transmission Fluid

- Transmitting power via torque converter ✓
 - Acting as hydraulic fluid via servo cylinder ✓
 - Acts as a heat-transfer medium ✓
 - Acts as lubricant for gears and bearings ✓
- Any 2 X 1 (2)**

5.2 Blower:

5.2.1 Roots blower ✓ (1)

5.2.2 1. Inlet ✓
2. Outlet ✓
3. Rotors ✓ (3)

5.2.3 Operation

- The engine drives the rotors by means of gears or chain ✓
- Air is trapped between the rotor and aluminium casing. ✓
- This air is carried around the outside of the rotor and is pushed into a decreasing volume. ✓
- This raises the pressure of the air with the rotational speed of the rotors. ✓
- The air is forced into the inlet manifold and then fed into the cylinders. ✓ (5)

5.3 Superchargers

- To fill the cylinder with air pressure higher than atmospheric pressure. ✓
- To increase the compression pressure in the cylinder. ✓
- To increase volumetric efficiency of the engine. ✓
- No lag in relation to turbo charger ✓
- Obtain more power ✓ **Any 3 X 1** (3)
-

5.4 Superchargers and turbochargers

- Supercharger is mechanically driven by gears or a belt. ✓
- Turbocharger is driven by the exhaust gases. ✓ (2)

5.5 Steam turbine uses

- To drive generators to generate electricity. ✓
- To operate ships. ✓
- To operate pumps ✓ **Any 2 X 1** (2)

5.6 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 engines. ✓
- Low maintenance ✓ **Any 4 X 1** (4)

[40]

QUESTION 6: FORCES AND SYSTEMS AND CONTROL**6.1 Hydraulics:****6.1.1 Fluid pressure:**

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

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

$$A_B = 31,41593 \times 10^{-3} m^2 \quad \checkmark$$

$$P = \frac{F_B}{A_B} \quad \checkmark$$

$$P = \frac{15 \times 10^3}{31,41593 \times 10^{-3}} \quad \checkmark$$

$$= 477464,8293 Pa$$

$$= 0,48 MPa \quad \checkmark$$

(6)

6.1.2 Force F on piston A:

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

$$A_A = \frac{\pi \times (0,075)^2}{4} \quad \checkmark$$

$$A_A = 4,4178 \times 10^{-3} m^2 \quad \checkmark$$

$$P_A = P_B$$

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

$$F_A = P_A \times A_A \quad \checkmark$$

$$F_A = (0,48 \times 10^6) (4,42 \times 10^{-3}) \quad \checkmark$$

$$F_A = 2,10935 kN \quad \checkmark$$

$$= 2,11 kN$$

$$\text{or } \frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \checkmark \checkmark$$

$$F_1 = \frac{F_2 \times A_1}{A_2} \quad \checkmark$$

$$= \frac{15 \times 10^3 \times 4,4178 \times 10^{-3}}{31,41593 \times 10^{-3}} \quad \checkmark$$

$$= 2,1093 kN \quad \checkmark$$

$$= 2,11 kN \quad \checkmark$$

(6)

6.1.3 Distance 'X':

$$V_B = V_A \quad \checkmark$$

$$A_B \times X = A_A \times L_A \quad \checkmark$$

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

$$X = \frac{(4,42 \times 10^{-3})(0,12)}{31,41 \times 10^{-3}} \quad \checkmark$$

$$X = 16,87499773 \text{ mm / stroke} \quad \checkmark$$

$$X = 16,87499773 \times 16 \quad \checkmark$$

$$X = 269,99 \text{ mm} \quad \checkmark$$

$$= 270 \text{ mm} \quad \checkmark$$

(6)

6.2 Stress and strain:

6.2.1 Side length:

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

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

$$A = \frac{30 \times 10^3}{6 \times 10^6} \quad \checkmark$$

$$A = 5 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$A = L^2 \quad \checkmark$$

$$L = \sqrt{A} \quad \checkmark$$

$$L = \sqrt{5 \times 10^{-3} \text{ m}^2} \quad \checkmark$$

$$L = 0,0707106 \text{ m} \quad \checkmark$$

$$L = 70,71 \text{ mm} \quad \checkmark$$

(8)

6.2.2 Strain:

$$E = \frac{\sigma}{\epsilon} \quad \checkmark$$

$$\epsilon = \frac{\sigma}{E} \quad \checkmark$$

$$\epsilon = \frac{6 \times 10^6}{90 \times 10^9} \quad \checkmark$$

$$\epsilon = 0,06667 \times 10^{-3} \quad \checkmark$$

$$= 6,67 \times 10^{-5} \quad \checkmark$$

(4)

6.2.3 **Change in length:**

$$\begin{aligned}\epsilon &= \frac{\Delta l}{o l} && \checkmark \\ \Delta l &= \epsilon \times o l \\ \Delta l &= 6,67 \times 10^{-5} \times 200 && \checkmark \\ &= 0,013 \text{ mm} && \checkmark\end{aligned}\quad (3)$$

6.3 **Belt drives:**6.3.1 **Rotational frequency of the driven pulley**

$$\begin{aligned}(D_{DN} + t) \times N_{DN} &= (D_{DR} + t) \times N_{DR} && \checkmark \\ N_{DN} &= \frac{(D_{DR} + t) \times N_{DR}}{(D_{DN} + t)} && \checkmark \\ &= \frac{(475 + 12) \times 1440}{(180 + 12)} && \checkmark \\ &= \frac{487 \times 1440}{192} && \checkmark \\ &= 3652,5 \text{ rpm} && \checkmark\end{aligned}$$

Or

$$N_1 D_1 = N_2 D_2 \quad \checkmark$$

$$N_2 = \frac{N_1 D_1}{D_2} \quad \checkmark$$

$$= \frac{475 \times 1440}{180} \quad \checkmark$$

$$= 3800 \text{ rpm} \quad \checkmark$$

(5)

6.3.2 **Belt speed:**

$$\begin{aligned}V &= \frac{\pi(D+t) \times N}{60} && \checkmark \\ &= \frac{\pi(0,475 + 0,012) \times 1440}{60} && \checkmark \\ &= 36,72 \text{ m.s}^{-1} && \checkmark\end{aligned}\quad (3)$$

6.4 **Clutches:**6.4.1 **The maximum torque transmitted:**

$$T = \mu W n R$$

$$T = 0,3 \times 4 \times 10^3 \times 2 \times \frac{0,28}{2} \quad \checkmark$$

$$= 0,3 \times 4 \times 10^3 \times 2 \times 0,14 \quad \checkmark \checkmark$$

$$= 336 \text{ Nm} \quad \checkmark \checkmark$$

(5)

6.4.2 Power transmitted at 3500 rpm in kW:

$$P = \frac{2\pi NT}{60} \quad \checkmark$$

$$P = \frac{2\pi \times 3500 \times 336}{60} \quad \checkmark \checkmark$$

$$P = 123,15 \text{ kW} \quad \checkmark$$

(4)
[50]

TOTAL: 200