Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

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MECHANICAL TECHNOLOGY MEMORANDUM

MARKS: 200

This memorandum consists of 10 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1	D ✓	Make certain the dipstick is in the hole.	(1)
1.2	D ✓	All the abovementioned.	(1)
1.3	B ✓	Guards should be removed when cutting metals.	(1)
1.4	C ✓	Multimeter	(1)
1.5	C ✓	deflection	(1)
1.6	C ✓	iron carbide	(1)
1.7	B ✓	480 °C - 520 °C	(1)
1.8	D ✓	25 mm	(1)
1.9	B ✓	Cylinder head	(1)
1.10	A ✓	To determine the percentage of elongation of the weld metal.	(1)
1.11	B ✓	To check for size of the weld	(1)
1.12	D ✓	Resultant	(1)
1.13	A ✓	25 MPa	(1)
1.14	B ✓	It must increase the engine speed.	(1)
1.15	B ✓	'Winter grades'	(1)
1.16	C ✓	16 : 1	(1)
1.17	C ✓	Block and tackle	(1)
1.18	D ✓	ABS braking system	(1)
1.19	C ✓	mechanical drive.	(1)
1.20	C ✓	Kaplan	(1)

[20]

QUESTION 2: SAFETY

2.1
- Make sure all the guards are in place. ✓
- Do not use or come close to its moving parts while wearing loose clothing. ✓
- Keep any cleaning material such as waste and rags away from rotating parts.
- Check that there are no oil or grease on the floor around the machine.
- Do not leave spanners or keys on rotary parts. (Any 2 x 1) (2)

2.2
- The welding operator should know how to operate the oxy-acetylene welding plant safely. ✓
- The work place should be partitioned off effectively. ✓
- The operator should wear protective equipment.
- Never use damaged equipment.
- Never use oil or grease near oxygen equipment. (Any 2 x 1) (2)

2.3
- Ensure that the beam is clamped parallel to the back board. ✓
- Do not leave plastic beams loaded for any length of time. ✓
- Gently drop the weights onto the hanger. ✓ (3)

2.4
- The operator should be instructed to use the machine safely. ✓
- The work place should be effectively partitioned off. ✓
- An operator uses protective equipment while using the equipment. ✓
- The operator should ensure that the insulation of electric leads are satisfactory. (Any 3 x 1) (3)

[10]

QUESTION 3: TOOLS AND EQUIPMENT

3.1
- It involves the indenting of the test material with a diamond cone or hardened steel-ball indenter.✓
- The indenter is forced into the test material under a preliminary minor load (FO), usually 10 kgf.✓
- The permanent increase in depth of penetration, resulting from the application and removal of the additional major load, ✓ is used to calculate the Rockwell Hardness Number.✓ (4)

3.2
- To test the system for leaks. ✓
- To pump compressed air into the cooling system of a motor car to determine whether there are any leaks in the system. ✓
- To test if the pressure cap on the cooling system operates according to the prescribed pressure of the system. (Any 2 x 1) (2)

3.3 3.3.1
- To determine the fuel operating pressure in the system. ✓
- To test the pressure of the fuel in the fuel line that runs to the direct injection system. ✓ (2)

3.3.2
- To test different electrical components and concepts. ✓
- To test current, voltage, resistance, continuity, transistors and diodes. ✓ (2)

3.4 1 mm + 0,5 mm + 0,25 mm = 1,75 mm ✓✓ (2)

[12]

QUESTION 4: MATERIALS

4.1 4.1.1 Pearlite is a type of crystal formed before hardening when the steel contains 0,83% carbon. ✓✓ (2)

4.1.2 Carbon Content is the mixture that is added to steel to change the property of the metal. ✓✓ (2)

4.1.3 Martensite is the structure obtained when austenite is quenched suddenly. ✓✓ (2)

4.2
- Alloying ✓
- Heat treatment ✓ (2)

4.3 To increase service life of a product ✓or to prepare the material for improved manufacturability.✓ (2)

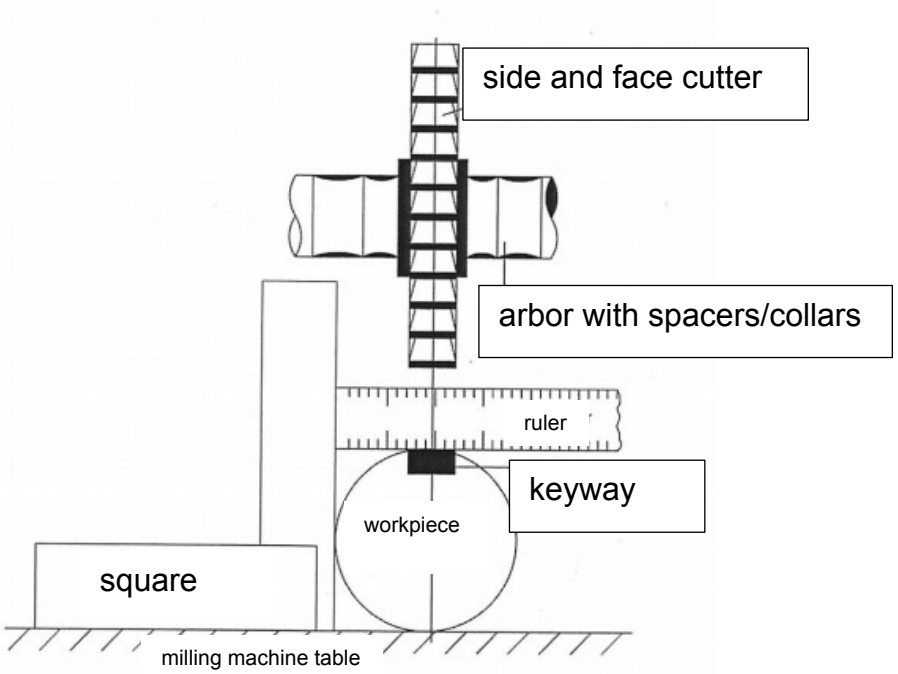
4.4 A map of the temperature at which different phase changes occur ✓ on very slow heating and cooling in relation to carbon. ✓ (2)

4.5 Iron carbide (which is a component of Iron carbon (Fe_2C) found in steel and cast iron. ✓ (1)

[13]

QUESTION 5: TERMINOLOGY

5.1



(6)

5.2 5.2.1 Conventional milling also regarded as up-cut milling is the process whereby the cutter turns against the direction of feed ✓as the work piece moves toward it from the side where the teeth are moving upwards. ✓ (2)

5.2.2 Climb milling also regarded as down-cut milling is the process where all looseness in the table-feed screw must be eliminated, ✓ where the motion of the cutter tends to pull the work piece into the cutter. ✓ (2)

5.3 Indexing required:
Number of turns = $\frac{40}{N}$ ✓ = $\frac{40}{43}$ ✓
There will be no turns but 40 holes in a 43 hole plate. ✓✓ (4)

5.4 Class 1: ✓ for screw thread work in which shake or play is not objectionable ✓
Class 2: ✓ for threaded parts that can be put together with the fingers(hand tight) ✓
Class 3: ✓ for higher grade of threaded parts, requiring greater accuracy ✓
Class 4: ✓ for the finest threaded work ✓ (8)

5.5 Identify: Milling process ✓
Name: Gear cutting ✓ (2)

5.6 A Anvil✓
B Screw thread✓
C Barrel✓
D Thimble✓
E Spindle✓
F Frame✓ (6)

[30]

QUESTION 6: JOINING METHODS

		DEFECT	PREVENTION	
6.1	6.1.1	Porosity✓	• Do not use dirty or wet electrodes ✓ • Do not use rusted MIG wire • Ensure the weld surface is not contaminated (Any 1 x 2)	(2)
	6.1.2	Incomplete penetration ✓	• Incorrect welding current ✓ • Travel speed to slow • Incorrect torch, gun or stick angle (Any 1 x 2)	(2)
	6.1.3	Slag inclusion ✓	• Chip the slag off thoroughly from the previous weld runs and brush the weld bead with a wire brush, before doing any further welding ✓ • Incorrect current setting (Any 1 x 2)	(2)

6.2
- Nick-break test ✓
- Nick-bend test ✓
- Machinability test ✓ (3)

6.3
- Continuous wire reel ✓
- Wire feed unit ✓
- Power cable ✓
- Gun conduit ✓
- Welding gun ✓
- Shielding gas cylinder ✓
- Regulator
- Flow meter
- Gas hose (Any 6 x 1) (6)

6.4
- Use a hacksaw and cut both edges through the centre of the weld approximately 6,5 mm deep. ✓
- Place the saw-nicked specimen on two steel supports ✓ and use a sledge hammer to break the specimen by striking it in the zone where you made the saw cuts. ✓
- The weld metal exposed in the break should be completely fused, ✓ free from slag inclusion and contain no gas pockets greater than 1,6 mm. ✓
- There should not be more than one pore or gas pocket per square centimetre visible. ✓ (6)

6.5
A Motor ✓
B Tension roller ✓
C Consumable wire reel ✓
D Wire liner ✓ (4)

[25]

QUESTION 7: FORCES

7.1 7.1.1 Diameter :

Stress = $\frac{FORCE}{AREA}$

8 x 10^6 = $\frac{40\ X\ 10^3}{AREA}$ ✓

Area = $\frac{40\ X\ 10^3}{8\ X\ 10^6}$ ✓

$\frac{\prod D^2}{4}$ = $\frac{40\ X\ 10^3}{8\ X\ 10^6}$ ✓

D = $\sqrt{\frac{40\ x\ 10^{3\ x\ 4}}{8\ x\ 10^6\ x\ \pi}}$ ✓

D = $\sqrt{0{,}006366197}$ ✓

D = 0,079788 m or 79,79 mm ✓ (6)

7.1.2 Young's Modulus = $\frac{Stress}{Strain}$

Strain = $\frac{Stress}{Young's\ Modulus}$ ✓

Strain = $\frac{8\ x\ 10^6}{60\ x\ 10^9}$ ✓

Strain = 0,0001333✓ or 1,333 x 10^{-4} ✓ (3)

7.1.3 Change in Length:

Strain = $\frac{Change\ in\ Length}{Original\ Length}$

Change in Length = Strain x Original Length ✓

= 0,0001333 x 275 ✓

= 0,0366575 mm ✓ (3)

7.2 7.2.1

A_P = $\frac{\pi\ X\ 0{,}034^2}{4}$

A_P = 0,00090792 m^2 ✓

P = $\frac{F_P}{A_P}$

P = $\frac{320}{0{,}00090792}$ ✓

P = 352453,8532 kN ✓ (3)

7.2.2 Diameter of the Ram:

A_R = $\frac{F_R}{P}$

= $\frac{35\ X\ 10^3}{352453{,}8532}$

= 0,09930378 ✓

BUT: Area = $\frac{\pi\ D^2}{4}$

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

D = $\sqrt{\frac{4A}{\pi}}$ ✓

= $\sqrt{0{,}1264375}$ ✓

= 0,3555805 m

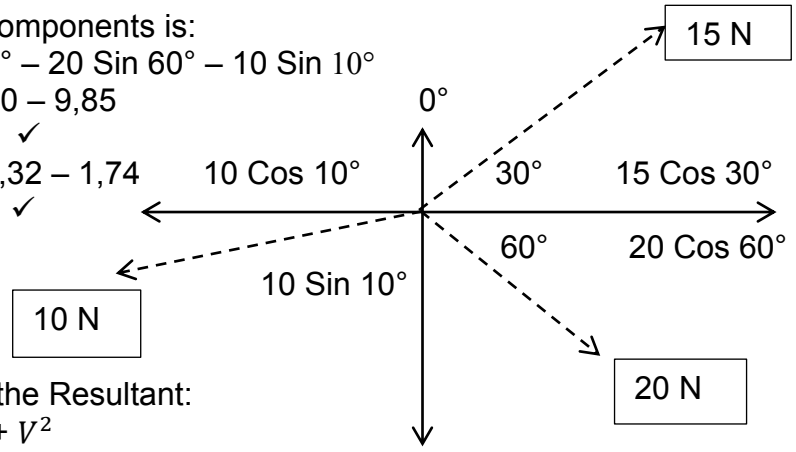
Diameter of Ram = 35,5 mm ✓ (4)

7.3 L :(R x 8 = (8 x 2) + (50 x 4) + (30 x 10) ✓
= 16 + 200 + 300
R = $\frac{516}{8}$ ✓
R = 64,5 N ✓

R : (L x 8) + (30 x 2) = (50 x 4) + (8 x 6) ✓
(L x 8) + 60 = 200 + 48
RL = $\frac{188}{8}$ ✓
RL = 23,5 N ✓

To check if the beam is in equilibrium:
Downward forces = Up ward forces
8 + 50 N + 30 N = 64,5 N + 23,5 N
88 N = 88 N (6)

7.4 Solution:
The horizontal component of the resultant is:
H = 15 Cos 30° + 20 Cos 60° – 10 Cos 10°
AND
The vertical components is:
V = 15 Sin 30° – 20 Sin 60° – 10 Sin 10°
H = 12,99 + 10 – 9,85
= 13,14 N ✓
V = 7,5 – 17,32 – 1,74
= - 11,56 N ✓



To Calculate the Resultant:
$R^2 = H^2 + V^2$
= $\sqrt{13{,}14^2} + (-11{,}56)^2$
= 17,499 N ✓
Tan ∅ = $\frac{V}{H}$
∅ = $Tan^{-1}\frac{11{,}56}{13{,}14}$
= 41,34° ✓
The Resultant is therefore 17,499 N at 131,34° ✓ (5)
[30]

QUESTION 8: MAINTENANCE

8.1 A Gear lever ✓
B Selector for gear changes ✓
C Splined input shaft ✓
D Lay shaft ✓ (4)

8.2 Because it gives of vapours which ignite✓ and therefore a high flashpoint is required. ✓ (2)

8.3 It is used in the turning process on a lathe✓ as illustrated by the drawing, cutting a thread on a shaft. ✓ (3)

8.4 A Flywheel ✓
B Diaphragm ✓
C Crankshaft ✓
D Clutch plate ✓
E Throw-out release lever ✓
F Pressure plate ✓ (6)

[15]

QUESTION 9: SYSTEMS AND CONTROL

9.1 9.1.1 Rotational Frequency of the output shaft:

Output shaft $N_D = \frac{T_C}{T_D} \times \frac{T_A}{T_B} \times N_A$ ✓

$= \frac{14}{42} \times \frac{16}{12} \times 1330$ ✓

$N_D = 591{,}11$ r/min ✓ (3)

9.1.2 Velocity Ratio:

$VR = \frac{N_A}{N_D}$

$= \frac{1330}{591{,}11}$ ✓

Velocity Ratio = 2,25 revs/min ✓ (2)

9.2 9.2.1 Fluid Pressure:

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

$= \frac{\pi(0{,}035)^2}{4}$

$= 0{,}00384845\ m^2$

$= 3{,}848 \times 10^{-3}\ m^2$ ✓

$P_A = \frac{F}{A_A}$

$= \frac{400}{3{,}848}$ ✓

= 103937,9 Pa

= 103,937 kPa✓ (3)

9.2.2 Load that can be lifted:

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

$= \frac{\pi(0{,}145)^2}{4}$

$= 0{,}0165\ m^2$

BUT $P_A = P_B$

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

$F = P_B \times A_B$

= 103937,9 x 0,0165 ✓

= 1716,32 N

= 1,716 kN ✓ (2)

9.3 9.3.1 Rotational Frequency of the driven pulley.

$N_1 \times D_1 = N_2 \times D_2$

$N_2 = \frac{N_1 \times D_1}{D_2}$

$= \frac{100 \times 40}{120}$ ✓

= 3,33 r/min ✓ (2)

OR

$$\frac{Speed\ of\ driver\ pulley\ A}{Speed\ of\ driven\ pulley\ B} = \frac{Diameter\ of\ driven\ pulley\ B}{Diameter\ of\ driver\ pulley\ A}$$

$$\frac{100\ r/min}{Speed\ of\ driven\ pulley\ B} = \frac{120}{40}$$

120 (Speed of driven pulley B) = 40 x 100

Speed of driven pulley = $\frac{400}{120}$

= 3,33 r/min

9.3.2 Power transmitted:

P = $\frac{(T_{1-}T_{2)}\ \pi DN}{60}$

= $\frac{(130-60)\ \pi\ 0{,}0.40\ .100}{60}$ ✓

Power transmitted = 14,6 watt ✓ (2)

9.3.3 Belt speed:

V = $\frac{\pi DN}{60}$

= $\frac{\pi.0{,}04\ .100}{60}$ ✓

= 0,209 m/sec ✓ (2)

9.4 New Pressure:

P_2 = $\frac{P_1\ V_1}{V_2}$ OR $P_1\ V_1$ = $P_2\ V_2$

300 x 0,35 = P_2 x 0,9 ✓

P_2 = $\frac{300\ x\ 0{,}35}{0{,}9}$ ✓

= 116,66 kN/m^2 ✓

= 116,66 kPa ✓ (4)

9.5 <u>Purpose of airbags</u>:

- It provides protection for the head and upper body of the driver and passengers of a motor vehicle during a collision. ✓
- In head on collisions, drivers and passengers are thrown forward inside the vehicles and when the airbags is activated, it inflates instantly ✓ and creates a firm barrier which counters the forward motion of the driver or front seat passenger. ✓
- It is designed to prevent the occupants from hitting the windscreen or dashboard of the vehicle. ✓
- It is also designed to work in conjunction with seat belts. ✓ (5)

[25]

QUESTION 10: TURBINES

10.1
A Wicket gate ✓
B Blades ✓
C Water flow ✓
D Rotor ✓
E Stator ✓
F Shaft ✓ (6)

10.2
- Reaction turbines ✓
- Impulse turbines ✓ (2)

10.3 Air is compressed isentropically, ✓ combustion occurs at constant pressure ✓ and expansion over the turbine occurs isentropically ✓ back to the starting pressure. ✓ (4)

10.4
- Advantages of steam turbines:
- It has greater thermal efficiency and higher power-to-weight ratio. ✓
- It is suited to drive an electrical generator. ✓
- It does not require a linkage mechanism to convert reciprocating motion to rotary motion. ✓
- It uses multiple stages in the expansion of the steam, which results in greater efficiency. ✓
- It is compact.
- No lubrication is required.
- Can be more accurately regulated.
- A variety of fuels can be used to obtain steam.
- It converts heat energy into mechanical energy (Any 4 x 1) (4)

10.5 Advantages of gas turbines:
- It has smooth vibration ✓
- It is easy to start ✓
- It has no rubbing parts such as pistons ✓
- No internal friction and wear ✓
- Higher power output from a given weight of engine
- Can use a wide range of fuels
- No water cooling system needed
- Require little routine maintenance
- Very little trouble with pollution (Any 4 x 1) (4)

[20]

TOTAL: 200