Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

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MECHANICAL TECHNOLOGY MEMORANDUM

MARKS: **200**

This memorandum consists of 12 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

QUESTION 2: SAFETY

2.1 2.1.1
- Every work place must be ventilated either by natural or mechanical means so that the air breathed by employees is safe.✓
- That the concentration therein of any explosive or flammable gas, vapour or dust does not exceed safety levels. ✓ (Any 1) (1)

2.1.2
- There must be adequate lighting in the work place. ✓
- The lighting on rotating machinery must not cause a flashing effect. ✓
- Lights and lamps must be kept clean and maintained. ✓ (Any 1) (1)

2.2
- Store full cylinders apart from empty ones. ✓
- Keep cylinders in a cool place and protect them from sunlight and other sources of heat.✓
- Always store and use cylinders in an upright position. ✓
- Store oxygen cylinders away from fuel cylinders. ✓
- Never stack cylinders on top of each other.
- Do not bang or work on cylinders.
- Never allow cylinders to fall from any height.
- Do not allow grease or oil to come into contact with oxygen fittings.

(Any 4 x 1) (4)

2.3
- All driving belts must be guarded. ✓
- Driving belts must never be adjusted while the machine is in motion.

(Any 1) (1)

2.4 To make the workplace as safe as possible. ✓ (1)

2.5
- Fixed guards. ✓
- Automatic guards. ✓
- Manual guards.
- Self-adjusting guards.
- Automatic sweep-away or push-away guards. (Any 2 x 1) (2)

[10]

QUESTION 3: TOOLS AND EQUIPMENT

3.1
- All connections must be secured. ✓
- Insulation and electrical leads must be in sound condition. ✓
- Electrode holders must be properly insulated to prevent accidental contact with current-carrying components. ✓
- Machines must be regularly serviced and well maintained. ✓ (4)

3.2 To measure an inside diameter ✓ or the inside of two parallel surfaces accurately. ✓ (2)

3.3 3.3.1 It is a machine that cuts material by means of a mechanical or electrical method. ✓ (1)

3.3.2 It is used for cutting to length various metals of different sizes, kinds and shapes. ✓ (1)

3.4 3.4.1 A suitable hole must be drilled a little larger than the core diameter of the tap. ✓ (1)

3.4.2 Clearance size is the size of the hole that must be drilled so that the hole will clear the outside diameter of a screw or bolt. ✓ (1)

3.5 For heating, bending, gas welding, brazing and silver soldering.✓ (Any 1) (1)

3.6 It is used when you want to press bearings on shafts or remove them from shafts. ✓
You use it to push a shaft with a bearing into a housing like the water pump of a motor car. (Any 1) (1)

[12]

QUESTION 4: MATERIALS

4.1 It is the change in the structure of metals by the application of heating and cooling in their solid states ✓ so as to change their properties. ✓ (2)

4.2
- Open-hearth furnace ✓
- Basic oxygen furnace ✓
- Electric furnaces ✓ (3)

4.3 Tempering: ✓ It is a process applied to steel to relieve the strain induced during the hardening process to reduce brittleness. ✓
Case Hardening: ✓ It is a surface hardening process to put a case over a tough core. ✓
Case Hardening: ✓ It is a surface hardening process to put a case over a tough core. ✓ (Any 2 x 2) (4)

4.4 It should be cooled down to room temperature, ✓ in still air or away from draughts. ✓ (2)

4.5 Water, ✓oil ✓or brine (Any 2 x 1) (2)
[13]

QUESTION 5: TERMINOLOGY

5.1 Mass production is the manufacturing or fabrication of products on a massive scale. ✓ (1)

5.2 FIGURE 5.3 A – Convex cutter. ✓ (1)
FIGURE 5.3 B – Double Equal angle cutter. ✓ (1)

5.3 5.3.1 FIGURE 5.3 A: Rapid indexing, known as direct indexing is where the worm shaft is disengaged from the worm wheel in the dividing head ✓ for quick indexing to cut squares, hexagons, pentagons, etc. ✓ (2)

5.3.2 FIGURE 5.3 B: Simple indexing is used to turn the crank ✓ to cut the number of teeth on the circumference of the work piece. ✓ (2)

5.4 N(Gear with teeth) = 88

$$\text{No. of turns} = \frac{40}{N}$$
$$= \frac{40}{88} \checkmark$$
$$= \frac{40}{88} = \frac{5}{11}$$
$$= \frac{5}{11} \times \frac{6}{6} \checkmark$$
$$= \frac{30}{66} \checkmark$$

No full turns on the crank handle and 30 holes in a 66 hole circle. ✓ (4)

5.5 Angle = $\frac{D-d}{2\ x\ L}$ ✓

= $\frac{80-50}{2\ X\ 70}$ ✓

= $\frac{30}{140}$ ✓

= 0,214

Θ = 12° 75" ✓

Helix angle is 12° and 75 minutes. ✓ (5)

5.6 Indexing = $\frac{40}{N}$

= $\frac{40}{5}$ ✓

No of turns = 8 full turns of the crank handle ✓

Therefore sin Θ = $\frac{X}{60}$ ✓

X = 60 sin Θ

X = 60 sin 72°

X = 57,06 mm ✓

Depth cut = $\frac{Diameter\ of\ shaft\ -\ Distance\ across\ the\ flat\ side}{2}$

= $\frac{60-x}{2}$

= $\frac{60-57,06}{2}$ ✓

Depth of cut = 1,47 mm ✓ (6)

5.7 Taper turning is a process of producing a conical (pointed) profile, ✓ which equally increases or decreases in diameter ✓ as the cutting tool is fed longitudinally along the rotating work piece on the lathe. ✓ (3)

5.8
- The milling cutter should correspond with the centre of the work piece. ✓
- To centre the milling cutter on the work piece, measure the thickness of the cutter and mount the cutter on the arbor. ✓
- Measure the diameter of the work piece and position a square on the machine table against the work piece. ✓
- Measure from the square to the inner side of the milling cutter ✓ a distance equal to half the diameter of the work piece minus half of the width of the milling cutter.✓ (5)

[30]

QUESTION 6: WELDING JOINTS

6.1 A – Size of weld.✓
B – Root gap.✓
C – Length of weld.✓
D – Pitch of weld.✓
E – Weld all round.✓
F – Type of welding.✓
G – Arrow side of weld.✓ (7 x 1) (7)

6.2 FIGURE 6.2A: It is used for soldering electric components. ✓ (1)
FIGURE 6.2B: It is used for soldering copper plumbing pipes. ✓ (1)

6.3
- Type of material used. ✓
- Number of welds. ✓
- Type of welding rod used. ✓
- Size of the weld. ✓
- The preparation.
- The presence of oxygen/hydrogen. (Any 4 x 1) (4)

6.4 A – Fillet weld (both sides) ✓
B – Square butt weld (arrow sides) ✓
C – V-Butt weld (both sides) ✓
D – Single bevel weld (arrow side) ✓
E – U-Butt weld (arrow side) ✓
F – J-Butt weld (arrow side) ✓ (6)

6.5 A – Slag ✓
B – Gas envelope ✓
C – Coating ✓
D – Weld metal ✓
E – Molten pool ✓
F – Parent metal ✓ (6 x 1) (6)
[25]

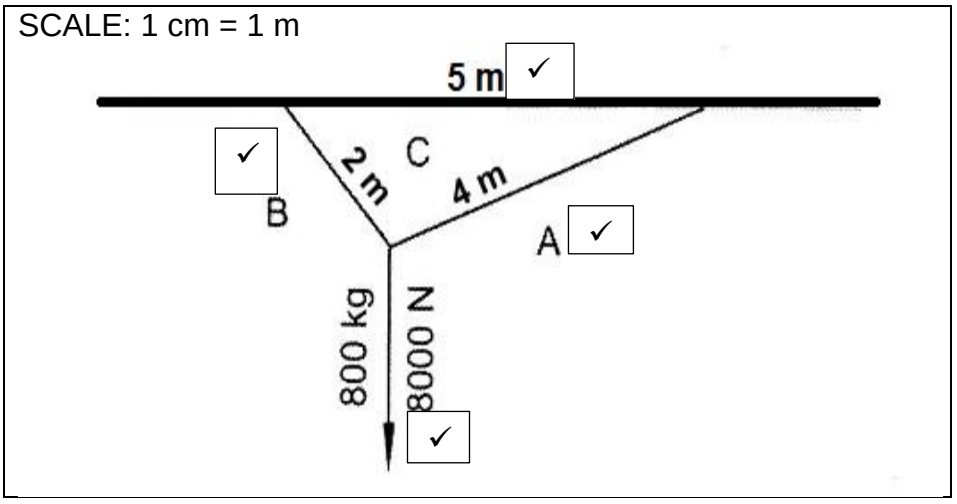
QUESTION 7: FORCES

7.1 7.1.1 Equilibrium: When two or more forces act on a body and the body remains at rest, the forces are said to be in equilibrium. ✓ (1)

7.1.2 Resultant: If a system of forces acts on a body and a single force can be found that has the same effect as the system, ✓ that single force is known as the resultant of the system. ✓ (2)

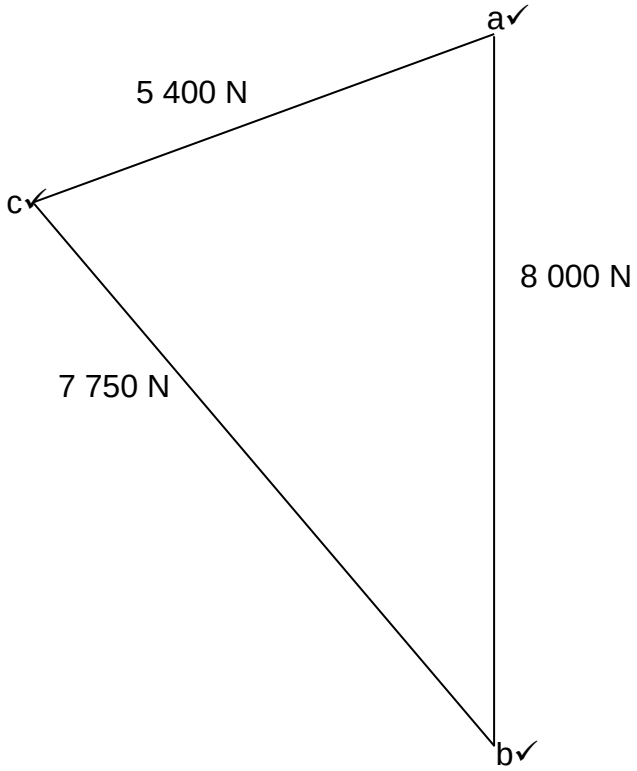
7.1.3 Bow's Notation: It is a method which can be used to simplify problem solving ✓ where three or more forces are applied to a body in a system of forces. ✓ (2)

7.2 7.2.1



(4)

7.2.2 SCALE: 1 mm = 100 N



(3)

7.2.3
- The tension in rope bc has a magnitude of 7 750 N. ✓
- The tension in rope ca has a magnitude of 5 400 N. ✓ (2)

7.3 7.3.1 RR: (RL x 9) = (12 x 3) + (16 x 7) ✓

$= 36 + 112$

$RL \times 9 = 148$

$RL = \frac{148}{9}$

$RL = 16{,}44$ N ✓

RL: (RR x 9) = (16 x 2) + (12 x 6) ✓

$= 32 + 72$

$RR \times 9 = 104$

$RR = \frac{104}{9}$

$RR = 11{,}55$ N ✓ (4)

The beam is in equilibrium, because the downward forces = upward forces.

7.3.2 BM: A = (16,44 x 2) ✓ = 32,88 N ✓ (2)

BM: B = (16,44 x 6) – (16,44 x 4) ✓ = 34,64 N ✓ (2)

7.3.3 Downward forces = Upward forces

16 N + 12 N = 16,4 N + 11,55 N ✓

28 N = 28 N ✓ (2)

7.4 Given:

Load: 70 kN = 70 x 10^3

Round Tube = 50 x 3 mm

Cross sectional area =?

Cross sectional area = $\frac{\pi x 50^2}{4} - \frac{\pi x 44^2}{4}$ ✓

$= 1963{,}495 – 1520{,}53$

$= 442{,}964$ mm² ✓

Convert to m² = $\frac{442{,}964}{10^6}$ ✓

: Stress = $\frac{Load}{Cross\ sectional\ area}$

$= \frac{70 x 10^3}{\frac{442{,}964}{10^6}}$

$= \frac{70 x 10^3 x 10^6}{442{,}964}$ ✓

$= \frac{70 x 10^9}{442{,}964}$

$= 158026385{,}9$ Pa (N/m^2) ✓

$= 158{,}026 \times 10^6$Pa

= 158,026 MPa ✓ (6)

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QUESTION 8: MAINTENANCE

8.1 Positive camber is the outward tilt ✓ of the wheel at the top away from the vehicle when viewed from the front. ✓ (2)

8.2 Check for the following:

- Uneven wear ✓
- Tyre pressure ✓
- Wheels for run-outs ✓
- Kingpins and bushes for wear
- Suspension ball joints for wear, locking and lifting
- Tie-rod ends for excessive free play
- Ineffective shock absorbers (Any 3 x 1) (3)

8.3

- Static balancing: A crankshaft is in static balance when the mass in all directions from the centre of rotation is equal while the crankshaft is at rest. ✓
- Dynamic balancing: A crankshaft is in dynamic balance when the centrifugal forces of rotation in all directions at any point are equal while the crankshaft is rotating. ✓ (2)

8.4

- Lack of lubrication ✓
- Overheating ✓
- Inadequate cooling ✓
- Inadequate maintenance ✓ (4)

8.5 8.5.1 It is used to determine the quantity of fuel to be injected into the system. ✓ (1)

8.5.2

- It is used to adjust the exact timing of the spark to provide better power and economy. ✓
- It will identify all the faults in the ignition system. (Any 1) (1)

8.6 It is the difference in the distances between the wheel rims or tyre thread centres, ✓ measured at stub axle height behind and in front of the axle or suspension. ✓ (2)

[15]

QUESTION 9: SYSTEMS AND CONTROL

9.1
- It is used to change the direction/s of a force or motion.
- To cause two parts to move at once.
- To make objects move identically to each other. (3)

9.2
- Switch ignition switch off; turn the crankshaft pulley until the number one piston is at TDC. ✓
  Check the timing marks on the crank pulley to be in line with the mark on the timing cover/ flywheel mark/pointer. ✓
- Loosen the clamp bolt of the distributer and switch on the ignition.
- Turn the distributer casing in the opposite direction to the rotor direction until the test lamp comes on, ✓ which indicates the contact points about to open; a spark or high voltage current will jump across the points. ✓
- Tighten the clamp bolt of the distributer casing.
- Static timing is completed. ✓ (5)

9.3 $\frac{Revolutions\ of\ final\ driven\ gear}{Revolutions\ of\ first\ driver\ gear} = \frac{Product\ of\ number\ of\ teeth\ on\ all\ the\ drivers}{Product\ of\ number\ of\ teeth\ on\ all\ the\ driven\ gears}$ ✓

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

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

$N_D = \frac{30}{60} \times \frac{50}{80} \times 20$ ✓

N_D = 6,25 revs/sec ✓

Rotational frequency of driven shaft = 6 revs/sec (rounded off) ✓ (6)

9.4 First determine the liquid area of the plunger:

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

= $\frac{\pi \times 50^2}{4 \times 10^6}$ OR Area = $\frac{\pi \times 50 \times 50}{4 \times 10^6}$ ✓

= 0,0019635 m^2 ✓

Pressure in jack

Pressure = $\frac{Force}{Liquid\ Area}$

Pressure = $\frac{300}{0{,}0019635}$ ✓

= 152788,3881 Pa ✓

Liquid Area in ram:

Area = $\frac{\pi \times 500^2}{4 \times 10^6}$ OR Area = $\frac{\pi \times 500 \times 500}{4 \times 10^6}$ ✓

= 0,19635 m^2 ✓

Load lifted by jack:

Pressure = $\frac{Force/Load}{Area}$

Load = Pressure x Liquid Area ✓

= 152788,3881 x 0,19635 ✓

Load = 30 000 N OR 30 kN ✓ (9)

9.5 Meshing gears is when two gears interlock or engage without slipping, ✓ having the same module. ✓ (2)

[25]

QUESTION 10: PUMPS

10.1
- Worn external packing, which allows the pump to draw air during the suction stroke. ✓
- Worn internal packing which allows the fluid to slip from the one fluid chamber to the other fluid chamber. ✓
- A strainer exposed above the fluid level. ✓
- A faulty foot valve. ✓
- Faulty or loose flanges or joints. ✓
- A weak or faulty seat or spring in the valve. (Any 5 x 1) (5)

10.2
- A mono pump is a displacement pump.
- The rotor seals tightly against the rubber stator as it rotates, forming a set of fixed-size cavities in between. ✓
- The cavities move when the rotor is rotated but their shape or volume does not change. ✓
- The pumped material is moved inside the cavities. ✓
- The liquid is forced through the space between the stator and the rotor. ✓ (4)

10.3

Gear Pump – Advantages	**Rotor Pump – Advantages**
The pump is very efficient and develops a high pressure✓ There are no reciprocating parts which can cause vibrations. The drive is always positive. It has no valves or springs (Any 1) (1)	There are no valves or springs.✓ All movements are rotary movements. Wear is minimal. Operation of the pump is silent. Large inlet and outlet parts ensures a steady flow of oil without pulsation. (Any 1) (1)
Gear Pump – Disadvantages	**Rotor Pump – Disadvantages**
Wear between the gears and the housing reduces the pump pressure.✓ When the gears wear, the pump tends to be noisy. (Any 1) (1)	Manufacturing costs are high ✓ (1)

(4)

10.4
- When the shaft drives the drive gear, it drives the driven gear and small pockets of oil are trapped between the gear teeth and the pump housing. ✓
- The rotation spaces between the teeth carry the oil towards the outlet port. ✓
- At the same time a vacuum is created over the inlet port and the oil is drawn from the sump. ✓
- The pressure forces the oil through the outlet port, from where it is fed to the oil channels. (4)

10.5
- Centrifugal pumps are more compact. ✓
- The initial cost is relatively low. ✓
- Low maintenance cost. ✓
- Centrifugal pumps are quite adaptable.
- The construction of the pump is simple and reliable.
- The pump works at high speed and can be connected to a motor directly.
- Centrifugal pumps have no moving values or sensitive parts.

(Any 3 x 1) (3)

[20]

TOTAL: 200