Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

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MECHANICAL TECHNOLOGY MARKING GUIDELINE

MARKS: **200**

This marking guideline consists of 9 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

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QUESTION 2: SAFETY

2.1 Oil and grease are flammable and may cause a fire. ✓✓ (2)

2.2
- Store full cylinders and empty ones separately. ✓
- Keep cylinders in a cool place. ✓
- Protect them from sunlight and other sources of heat. ✓
- Always store and use acetylene cylinders in an upright position.
- Store oxygen and acetylene cylinders separately
- Never stack cylinders on top of one another.
- Do not bang or work on cylinders.
- Never allow cylinders to fall.
- Do not allow oil or grease to come into contact with oxygen fittings.
- Keep the caps on an oxygen cylinder for protection. (Any 3) (3)

2.3
- An operator should be instructed to use a machine safely. ✓
- A workplace must be effectively partitioned off. ✓
- An operator must use protective equipment.
- Effective ventilation must be provided and maintained.
- Masks or hoods maintaining a supply of safe air for breathing must be provided and used by the operators.
- The insulation of electrical leads must be satisfactory.
- The holder which contains the wire must be completely insulated. (Any 2) (2)

2.4 2.4.1
- 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) (1)

2.4.2
- Make sure the guard is well secured before switching on the machine. ✓
- Machine guard must be in a good condition. ✓ (Any 1) (1)

2.4.3
- Keep hands away from rotating chuck. ✓
- Don't leave the chuck key in the chuck. ✓
- Make sure the chuck is well secured before switching on the machine. ✓
- Turn the chuck by hand to be certain that there is no danger of the work piece striking any part of the lathe. ✓ (Any 1) (1)

[10]

QUESTION 3: TOOLS AND EQUIPMENT

3.1
- Brinell hardness tester ✓
- Rockwell hardness tester ✓
- Vickers tester ✓ (Any 2) (2)

3.2
- Check for worn cylinders ✓
- Check for worn piston rings ✓
- Check for worn pistons ✓
- Check for inlet valve leakage ✓
- Check for exhaust valve leakage ✓ (Any 3) (3)

3.3 A tensile tester measures the resistance of a material to a static or slowly applied tensile axial force. ✓✓ (2)

3.4
- Rich mixture setting ✓
- Incorrect idle speed ✓
- Faulty choke creating a rich mixture (jammed in the closed position) ✓

(Any 2) (2)

3.5
- Check if the measuring lead are inserted in the correct socket for the measurement. ✓
- Turn the function switch to the desired function. ✓
- If you do not know what size of reading to expect, then switch to the highest range first. ✓
- Connect the meter measuring lead probes to the correct points in the circuit to be tested. (Any 3) (3)

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QUESTION 4: MATERIALS

4.1
- Low carbon steel ✓ 0,10 – 0,25% ✓✓
- Medium carbon steel ✓ 0,25 – 0,55% ✓✓
- High carbon steel ✓ 0,55 – 1,00% ✓✓ (9)

4.2 The internal structural changes take place and it takes up an entirely new form at a temperature of about 800 °C. ✓✓ (2)

4.3 730° – 780 °C ✓✓ (2)

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QUESTION 5: TERMINOLOGY

5.1
- **Arbor cutters** ✓ (1)
  e.g. plain, side, staggered-tooth, metal slitting saw and form cutters ✓✓ (Any 2 examples)(2)
- **Shank cutters** ✓ (1)
  e.g. end mills, T-slot, Woodruff key seat and fly cutter ✓✓ (Any 2 examples)(2) (6)

5.2
- High abrasive resistance ✓
- Red hardness i.e. the hardness of the cutting edge must not be affected by heat generated. ✓
- Edge toughness ✓ (Any 2) (2)

5.3
- Turn the part to be threaded to the major diameter of the thread ✓
- Set compound slide 30^0 to the right and set tool up accurately in the tool post. ✓
- Check index plate of the quick-change gearbox and move the levers for the necessary pitch of the thread. ✓
- Start lathe and set cutting tool to touch work piece. Set dial to zero on cross feed and compound slide. ✓
- Move the cutting tool a short distance off to clear the end of the work piece and feed compound slide 0,05 mm inward. ✓
- With lathe turning, engage half-nuts in the correct line on the chasing dial, putting the first cut in progress. ✓
- Withdraw the cutting tool quickly and disengage the half-nut lever return the carriage to the starting point of thread and check with thread gauge to see if thread pitch is correct. ✓
- Repeat with successive cut until thread is complete. (Max. 7 x 1) (7)

5.4 5.4.1
- Form cutters ✓
- Profile cutters ✓ (Any 1) (1)

5.4.2 Number of turns = $\frac{40}{33}$ ✓ = $1\frac{7}{33}$ ✓
1 Full turn and 7 holes in a 33 hole-circle ✓ (3)

5.5
A Side and face milling cutters ✓
B Spindle nose ✓
C Vice fixed jaw ✓
D Parallels ✓
E Work piece ✓
F Shoulder width ✓
G Collars and spacers ✓
H Vice movable jaw ✓ (8)

5.6
A Major/Crest diameter ✓
B Pitch diameter ✓
C Minor or Root diameter ✓ (3)

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QUESTION 6: JOINING METHODS

6.1
A Regulator ✓
B Flow meter ✓
C Continuous wire reel ✓
D Wire feed roller unit ✓
E Gun conduit ✓
F Welding gun ✓
G Weld pool ✓
H Work piece ✓
I Earth clamp ✓ (9)

6.2
A Parent metal ✓
B Molten pool ✓
C Continuous electrode wire ✓
D Nozzle ✓
E Gas shroud ✓ (5)

6.3
- X-ray testing ✓
- Liquid dye penetrant ✓
- Ultrasonic testing ✓ (3)

6.4
- Make a hacksaw cut at both edges through the centre of the weld. ✓
- 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 free from slag inclusions and contain no gas pockets greater than 1,6 mm. ✓ (4)

6.5 To protect the weld area from oxygen and water vapour. ✓✓ (2)

6.6
- Solid metals entrapped in the weld metal or between the weld metal and the base metal. ✓
- Weld temperature is too low. ✓
- Included angle is too small. ✓
- Repeating a weld without removing the previous slag. ✓
- High viscosity of the molten metal. ✓ (Max. 2) (2)

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QUESTION 7: FORCES

7.1 7.1.1 A force is a push or a pull movement. ✓ (1)

7.1.2 It is a system in balance. ✓ (1)

7.1.3 It is a conversion of multiple forces into one. ✓ (1)

7.2 7.2.1 $\text{Stress} = \frac{F}{A}$

$A = \frac{F}{\text{Stress}}$ ✓

$\frac{\pi D^2}{4} = \frac{F}{\text{Stress}}$ ✓

$D^2 = \frac{F \times 4}{\pi \times stress}$ ✓

$D = \sqrt{\frac{4 \times 40 \times 10^3}{\pi \times 20 \times 10^6}}$ ✓

$D = \sqrt{2{,}546}$ ✓

D = 0,05045 m

D = 50,45 mm ✓ Diameter of bar (6)

7.2.2 $E = \frac{\text{Stress}}{\text{Strain}}$

$\text{Strain} = \frac{20 \times 10^6}{90 \times 10^9}$ ✓

$= 2{,}222 \times 10^{-4}$ ✓ (2)

7.2.3 $\text{Strain} = \frac{\text{Change in lenght}}{\text{Original lenght}}$ ✓

Change in length = Strain × Original length ✓

= 0,177 mm ✓ (3)

7.3 X-component = 280 N + 300 Cos 30° - 400 Cos 30° ✓✓

= 193,39 N ✓

Y-component = 300 Sin 30° + 400 Sin 30° - 170 ✓✓

= 150 + 200 + 170

= 180 N ✓

$R^2 = X^2 + Y^2$

$= 193{,}39^2 + 180^2$ ✓

$= \sqrt{69799{,}69}$

R = 264,19 N - resultant ✓

Calculation of the direction:

$\text{Tan } \Theta = \frac{180}{193{,}39}$ ✓

= 0,931

= 42,95° ✓ (10)

7.4 Reaction at **A**:

B × 6,2 = (496 × 3,1) + (350 × 7,9) ✓

= 1537,6 + 2765 ✓

B = 693,96 N ✓

Reaction at **B:**

(**A** × 6,2) + (350 × 1,7) = (800 × 6,2) + (496 × 3,1) ✓

(**A** × 6,2) = 4960 + 1537,6 – 595 ✓

A = 952,03 N ✓

A + **B** = 693,96 + 952,03 = 1645,99

Downwards = 800 + 496 + 350 = 1646

The beam is in equilibrium (6)

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QUESTION 8: MAINTENANCE

8.1
- It prevents the shavings or metal chips from sticking and fusing to the cutting tool. ✓
- It will carry the heat generated by the turning process. ✓
- It flushes away shavings/metal chips. ✓
- It improves the quality of the finish of the turned surface. ✓ (Max. 3) (3)

8.2
- Formation of gum, acids and lacquer may be left by the oil to coat the surfaces. ✓
- Oil loses its viscosity after a while due to excessive heat transfer which results in friction of lubricating efficiency. ✓
- Metal particles deposit in the oil due to metal and metal contact. ✓ (Max. 3) (3)

8.3 8.3.1 It is the lowest temperature at which the oil gives off vapours which can ignite ✓✓ (2)

8.3.2 It is the lowest point at which a liquid remains 'pourable' (meaning it still behaves like a fluid) ✓✓ (2)

8.4
- It must be water resistant, it must not mix ✓
- Rust/Corrosion resistant ✓
- Good for load pressure ✓
- High melting point ✓
- Low freezing point ✓ (Any 3) (3)

8.5
- To provide friction between the clutch and pressure plate ✓
- To connect the flywheel to the gearbox shaft ✓ (2)

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QUESTION 9: SYSTEMS AND CONTROL

9.1 9.1.1 First calculate the volume of cylinder B.

$$V_B = Area_B \times Stroke\ length_B \checkmark$$
$$= \frac{\pi \times D_B^2}{4} \times L_B$$
$$= \frac{\pi \times (0{,}18)^2}{4} \times 0{,}012 \checkmark$$
$$= 0{,}305 \times 10^{-3}\, m^3 \checkmark$$

But $V_A = V_B$

$$A_A \times L_A = V_B$$
$$A_A \times 0{,}06 = 0{,}305 \times 10^{-3} \checkmark$$
$$A_A = \frac{0{,}305 \times 10^{-3}}{0{,}06} \checkmark$$
$$= 5{,}08 \times 10^{-3}\, m^2 \checkmark$$
$$A_A = \frac{\pi D_A^2}{4}$$
$$D_A^2 = \frac{4 \times 5{,}08 \times 10^{-3}}{\pi} \checkmark$$
$$D_A = \sqrt{6{,}47 \times 10^{-3}} \checkmark$$
$$D_A = 0{,}80 \text{ m}$$
$$= 800 \text{ mm} \checkmark$$ (9)

9.1.2 Pressure at A $= \frac{F_A}{A_A}$

$P_A = \frac{550}{5{,}08 \times 10^{-3}}$ ✓

$= 108{,}268 \times 10^3$ Pa

$= 108{,}27$ kPa ✓ (2)

9.1.3 Note: Pressure at A is equal to pressure at B

$P_A = P_B$

$P_B = \frac{F_B}{A_B}$ ✓

$F_B = 108{,}268 \times 10^3 \times A_B$ ✓

$= 108{,}268 \times 10^3 \times 25{,}45 \times 10^{-3}$ ✓

$= 2755{,}42$ N

$F_B = 2{,}76$ kN ✓ (4)

9.2 9.2.1 Compressive stress ✓ (1)

9.2.2 $A = \frac{\pi(D^2 - d^2)}{4}$

$= \frac{\pi(0{,}04^2) - (0{,}03^2)}{4}$ ✓

$= 0{,}55 \times 10^{-3}\ m^2$ ✓

Stress $= \frac{Force}{Area}$

$= \frac{23 \times 10^3}{0{,}55 \times 10^3}$ ✓

$= 41818181{,}8$ Pa ✓

$= 41{,}82$ MPa ✓ (5)

9.3 9.3.1 Rotation of motor

$N_E = \frac{80 \times 40 \times 90}{30 \times 20}$ ✓

$= \frac{288000}{600}$

$= 480$ r/min ✓ (2)

9.3.2
- No slip occurs ✓
- It is much stronger ✓
- More accurate ✓
- Last longer ✓

(Any 2) (2)

[25]

QUESTION 10: TURBINES

10.1
- The supercharger fills the cylinder with an increased pressure that is higher than atmospheric pressure. ✓
- The compression pressure in the cylinder is increased. ✓
- The volumetric efficiency of the engine is increased. ✓ (Any 2) (2)

10.2
- Used in racing cars ✓
- Four-stroke compression ignition engines in heavy vehicles ✓
- Earth moving equipment ✓
- Aircraft engine to overcome loss of power owing to height above sea level ✓ (Any 2) (2)

10.3
- A turbine is driven by the exhaust gas from a pump, most often an internal combustion engine, to spin an impeller whose function is to force air into the pump's intake or air supply. ✓
- The shaped fins on the impeller move the air around to the outer edge of the impeller into the housing. ✓
- In doing so, the moving fins leave a low pressure behind it. ✓
- Air, under atmospheric pressure, rushes in to fill the low pressure at the centre of the impeller. ✓
- By spinning at a relatively high speed, the compressor turbine draws in a large volume of air and forces it into the engine. ✓
- As the turbocharger's output – flow volume exceeds the engine's volumetric flow, air pressure in the intake system begins to build. ✓
- The speed at which the assembly spins is proportional to the pressure of the compressed air and total mass of air flow being moved. ✓
- Since a turbo will spin faster than is needed, the speed must be controlled and thus it is also the property used to set the desired compression pressure. ✓ (8)

10.4
- Kinetic energy is the steam which is converted to mechanical energy to cause rotation. (mechanical energy) ✓
- Steam at very high temperature and pressure is directed to the turbine. ✓
- Nozzles are used to direct the pressure onto the blades. ✓
- The blades are attached to the turbine and shaft causing it rotate. ✓
- This is mechanical energy created by the impulse and the reaction effort of the steam jet. ✓ (5)

10.5
- Water turbines ✓
- Gas turbines ✓
- Wind turbines ✓ (3)

[20]

TOTAL: 200