basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY

NOVEMBER 2017

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

[20]

QUESTION 2: SAFETY

2.1 **Surface grinder:**

- Make sure the sparks are of no danger to co-workers. ✓
- Do not force the material onto the grinding wheel. ✓
- Do not plunge grind. ✓
- Bring the material slowly into contact with the grinding wheel. ✓
- Never clean or adjust the machine while it is in motion. ✓
- Use cutting fluid ✓
- Know where the emergency stop is located ✓
- Stop the machine before any adjustments ✓
- Keep tools clear from moving parts ✓

(Any 3x1) (3)

2.2 **Hydraulic press:**

- To make sure there is no leakages. ✓
- To make sure that the readings are accurate. ✓
- To make sure the prescribed pressure is not exceeded. ✓ (2)

2.3 **MIG/MAGS welding:**

- Working area must be well ventilated. ✓
- Make sure electrical parts are properly insulated. ✓
- Make sure the inert gas cylinder is fixed in an upright position. ✓
- Make sure the terminals are connected correctly to the right outlet points. ✓
- The operator should know how to use the equipment. ✓
- The operator must be completely insulated by means of boots, gloves and rubber mats. ✓
- The work area must be partitioned off. ✓
- Use protective equipment. (Overall, gloves, apron, welding helmet etc.) ✓
- Ensure adequate fire precautions. ✓
- See that there is no oil or grease around the machine. ✓
- Ensure that the working area is clean. ✓

(Any 3x1) (3)

2.4 **Spring compressor:**

- Make certain the compressor is strong enough for the spring ✓
- The compressor must be fitted correctly and firmly. ✓
- Ensure that the spring cannot slip out of position. ✓
- A uniform load must be applied. ✓
- Release the load carefully and also uniformly. ✓
- Do not use wire or ropes to compress the spring. ✓
- Do not hit with a hammer. ✓
- The hookes on the clamps shoul not be warned ✓
- Clamps must be evenly distributed ✓
- Do not exceed the maximum tension ✓

(Any 2x1) (2)

[10]

QUESTION 3: TOOLS AND EQUIPMENT

3.1 **Volt and ammeter:**

- Voltmeter: connected in parallel to a circuit. ✓
- Ammeter: connected in series to a circuit. ✓ (2)

3.2 **Uses of the multimeter:**

- Direct current measurement (DC) ✓
- Alternating current measurement (AC) ✓
- Voltage measurement ✓
- Resistance measurement ✓
- Transistor test ✓
- Diode test ✓
- Continuity test ✓
- Temperature ✓
- Battery test ✓

(Any 4x1) (4)

3.3 **Compression Test:**

- The piston rings are worn out. ✓✓
- Worn cylinders. ✓✓
- Cracked piston. ✓✓

(Any 1x2) (2)

3.4 **Tests:**

3.4.1 A beam bending test is to investigate the **deflection / bend** ✓✓ of beams. (2)

3.4.2 A cylinder leakage tester is to check whether **gases or air leaks** ✓✓ from the cylinders / **valve leak.** (2)

[12]

QUESTION 4: MATERIALS

4.1 **Properties of structures:**

4.1.1 Cementite: hard ✓ and brittle ✓ (2)

4.1.2 Ferrite: soft ✓ and ductile ✓ (2)

4.2 **Heating process of carbon steel:**

4.2.1 Iron-Carbon ✓ Equilibrium ✓ Diagram (2)

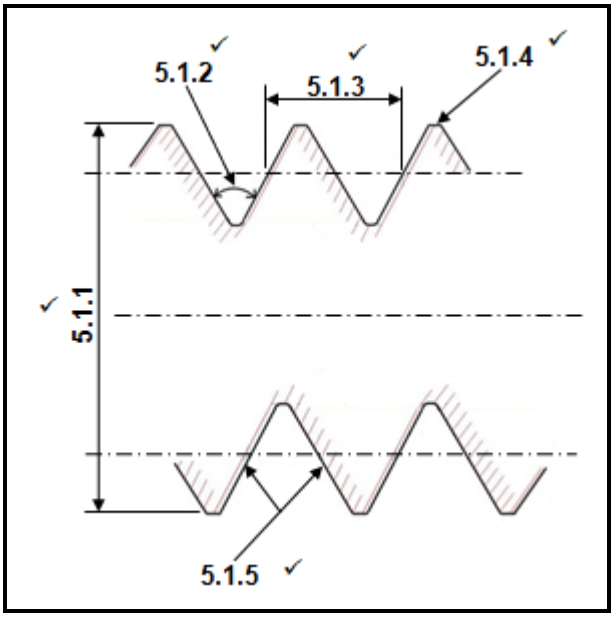
4.2.2 A = Ferrite and pearlite ✓
B = Pearlite and cementite ✓
C = Ferrite and austenite ✓
D = Austenite and cementite ✓
E = Austenite ✓ (5)

4.2.3 700 – 800 °C ✓✓ (2)

[13]

QUESTION 5: TERMINOLOGY

5.1 **Screw thread terms:**



5.1.3: **NOTE:** Any other corresponding point on the screw thread (5)

5.2 **Milling processes:**

5.2.1 Up-cut milling ✓ (1)

5.2.2 Down-cut milling ✓ (1)

5.3 **Indexing:**

$$Indexing = \frac{40}{A} \quad ✓$$

$$= \frac{40}{22}$$

$$= 1\frac{18}{22} \times \frac{3}{3} \quad ✓$$

$$= 1\frac{54}{66} \quad ✓$$

✓ ✓ ✓

1 full turn and 54 holes on the 66-hole circle (6)

5.4 **Dividing head:**

5.4.1 The sector arm save time and removes the possibility of error in counting the number of holes for each move of the index pin. ✓✓ (2)

5.4.2 The index plate is equipped with accurate spaced holes on different-diameter circles. Each circle has a different number of holes. These circles allow the crank handle to be given an accurate part of a turn to obtain the desired spacing. ✓ ✓ (2)

5.4.3 The index pin can be set in the crank handle so that it can be dropped into calculated hole and lock the crank the hole circles. ✓ ✓ (2)

5.4.4 Ratio between worm and worm gear: 40:1 ✓ ✓ (2)

5.5 **Gear terminology:**

5.5.1 **The pitch-circle diameter 'PCD'**

$$Module(m) = \frac{PCD}{T} \quad \checkmark$$

$$PCD = m \times T \quad \checkmark$$

$$= 3 \times 94$$

$$PCD = 282\,mm \quad \checkmark$$

(3)

5.5.2 **The outside diameter:**

$$Outside\ diameter = PCD + 2m \quad \checkmark$$

$$OD = 282 + 2(3)$$

$$OD = 288\,mm \quad \checkmark$$

(2)

5.5.3 **The dedendum:**

Dedendum $b = 1{,}157m$ or $b = 1{,}25m$ ✓

$b = 1{,}157 \times 3$ $b = 1{,}25 \times 3$

$b = 3{,}47\,mm$ $b = 3{,}75\,mm$ ✓

(2)

5.5.4 **The cutting depth:**

$Cutting\ depth = 2{,}157 \times m$ *or* $Cutting\ depth = 2{,}25 \times m$ ✓

$= 2{,}157 \times 3$ $= 2{,}25 \times 3$

$= 6{,}47\,mm$ $= 6{,}75\,mm$ ✓

(2)

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QUESTION 6: JOINING METHODS

6.1 **Causes of undercutting:**

- Current setting is too high ✓
- Current setting is too low ✓
- Faulty electrode manipulation ✓
- Arc length is too long ✓
- Welding speed is too fast ✓
- Incorrect electrode size ✓

(Any 2x1) (2)

6.2 **Prevention of slag inclusion:**

- Chip off the slag from the previous weld runs before doing any further welding. ✓✓
- Increase the current setting. ✓✓
- Ensure that the joint is properly cleaned before any welding is done. ✓✓
- Ensure constant current flow. ✓✓
- Arc length must be shorter ✓✓
- Use dry electrodes

(Any 1x2) (2)

6.3 **Liquid dye penetrant test:**

- Dye is sprayed onto the clean surface to be inspected ✓
- Allow a short time for the dye to penetrate, then remove excess dye with a solvent ✓
- Wash surface with water and allow to dry ✓
- When the surface is dry spray a developer on the surface to bring out the colour in the dye which is trapped in the cracks or pin holes ✓ (4)

6.4 **Advantages of using a MIGS/MAGS welding:**

- Operator needs less skills ✓
- Continuous welds can be done without replacing electrodes ✓
- Less cleaning of weld, (No slag to be removed) ✓
- It is a quicker process ✓
- Thin material can be welded easily ✓
- Can weld in any position ✓
- Create a better finish ✓
- High deposition rate ✓
- Less distortion ✓

(Any 3x1) (3)

6.5 **Gas flow meter:**

Control the flow of rate of shielding gas ✓ and measure the flow rate. ✓ (2)

6.6 **MIGS/MAGS welding process:**

A = Melted welding pool / Parent metal / Weld metal / Weld ✓
B = Contact nozzle / Weld pistol / gun ✓
C = Gas shroud / Weld pistol / gun ✓
D = Shielding gas ✓
E = Earth clamp / Skelm / Earth cable ✓ (5)

6.7 **Shielding gas in MIGS/MAGS:**

- To control the welding arc ✓✓
- Shield the molten pool from atmospheric gases ✓✓

(Any 1x2) (2)

6.8 **Earth cable:**

- To complete the circuit ✓✓
- To maintain constant current ✓ ✓
- To prevent electric shock ✓ ✓

(Any 1x2) (2)

6.9 **THREE types of gasses used for MIGS/MAGS welding:**

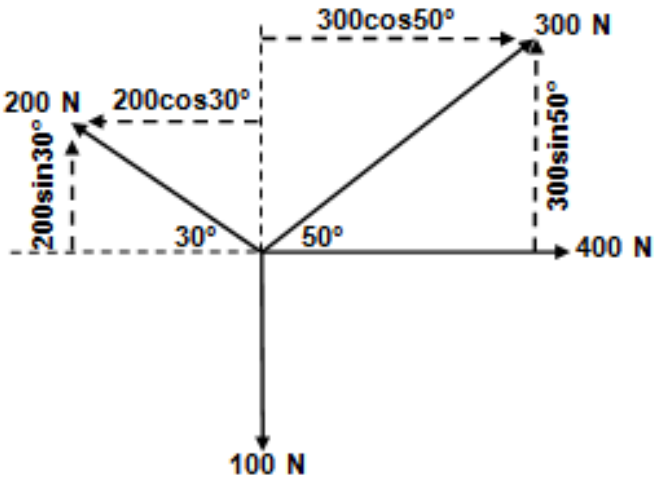
- Argon ✓
- Teral ✓
- CO_2 ✓
- Helium ✓
- Gas mixture ✓

(Any 3x1) (3)

[25]

QUESTION 7: FORCES

7.1



✓

$\Sigma HC = 300\cos 50° - 200\cos 30° + 400$

$= 192{,}84$ ✓ $- 173{,}21$ ✓ $+ 400$

$= 419{,}63N$ ✓

✓

$\Sigma VC = 200\sin 30° - 100 + 300\sin 50°$

$= 100$ ✓ $- 100 + 229{,}81$ ✓

$= 229{,}81N$ ✓

OR

Horizontal ✓ component	Magnitudes	Vertical ✓ component	Magnitudes
-200Cos30°	- 173,21 N ✓	200Sin30°	100 N ✓
300Cos50°	192,84 ✓	300Sin50°	229,81 N ✓
400 N	400 N	0	0 N
0	0 N	-100	- 100 N
TOTAL	**419,63 N ✓**	**TOTAL**	**229,81 N ✓**

$R^2 = HC^2 + VC^2$ ✓

$R = \sqrt{419{,}63^2 + 229{,}81^2}$

$R = 478{,}44N$ ✓

$Tan\theta = \dfrac{VC}{HC}$ ✓

$= \dfrac{229{,}81}{419{,}63}$

$\theta = 28{,}71°$ ✓

$R = 478{,}44N$ *at* $28{,}71°$ *north from east* ✓ (13)

7.2 Stress and Strain:

7.2.1 Stress in the bar:

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

$$= \frac{\pi \times 0{,}056^2}{4}$$

$$= 2{,}46 \times 10^{-3}\, m^2 \quad \checkmark$$

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

$$= \frac{40 \times 10^3}{2{,}46 \times 10^{-3}} \quad \checkmark$$

$$= 16260162.6\ Pa \quad \checkmark$$

$$= 16{,}26 \times 10^6\, Pa$$

$$= 16{,}26\, MPa$$

(5)

7.2.2 Strain:

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

$$\varepsilon = \frac{16{,}26 \times 10^6}{90 \times 10^9} \quad \checkmark$$

$$= 0{,}18 \times 10^{-3} \quad \checkmark$$

(3)

7.2.3 Change in length:

$$\varepsilon = \frac{\Delta l}{ol} \quad \checkmark$$

$$\Delta l = \varepsilon \times ol \quad \checkmark$$

$$= \left(0{,}18 \times 10^{-3}\right) \times 0{,}85$$

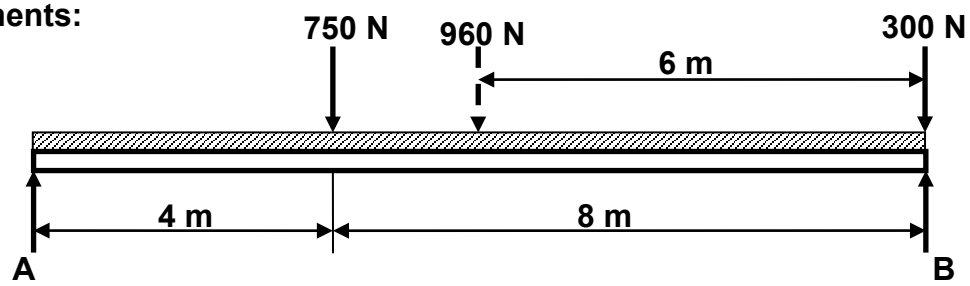
$$= 0{,}15 \times 10^{-3}\, m$$

$$OR \quad \checkmark$$

$$= 0{,}15\, mm$$

(3)

7.3 **Moments:**



Calculate A. Moments about B:

$$\sum \text{RHM} = \sum \text{LHM}$$

$$(A \times 12) = (960 \times 6) + (750 \times 8) \quad \checkmark\checkmark$$

$$\frac{12A}{12} = \frac{5760 + 6000}{12}$$

$$A = 980\,\text{N} \quad \checkmark$$

Calculate B. Moments about A:

$$\sum \text{LHM} = \sum \text{RHM}$$

$$(B \times 12) = (750 \times 4) + (960 \times 6) + (300 \times 12) \quad \checkmark\checkmark$$

$$12B = 3000 + 5760 + 3600$$

$$\frac{12B}{12} = \frac{12360}{12}$$

$$B = 1030\,\text{N} \quad \checkmark$$

(6)

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QUESTION 8: MAINTENANCE

8.1 **Pour point:**
The lowest temperature ✓ at which a liquid will flow. ✓ (2)

8.2 **Advantages of cutting fluids:**
- Keep the work piece and cutting tool cool ✓
- It prolongs the life of the cutting tool ✓
- Ensure a better finish ✓
- It washes the cuttings/swarf away ✓
- It protects the machine by making the cutting process easier ✓
- Prevents rust ✓
- It increases the productivity because ✓
- It is possible to cut faster ✓
- It lubricates the machine ✓

(Any 3x1) (3)

8.3 **'ATF':**
Automatic transmission fluid ✓✓ (2)

8.4 **Main parts of a clutch:**
Pressure plate ✓ clutch plate ✓ release bearing (Thrust bearing) ✓ (3)

8.5 **Results of a stretched chain:**
- The chain weakens ✓
- Generates friction ✓
- Vibration occurs ✓
- Becomes noisy ✓
- Derails easily ✓
- Tends to break easily ✓

(Any 3x1) (3)

8.6 **Causes of belt slip:**
- Incorrect tension (loose) ✓
- Oil on the contact surfaces ✓
- Worn belts ✓
- Incorrect pulley alignment ✓
- Overloading ✓
- Not the correct size ✓

(Any 2x1) (2)

[15]

QUESTION 9: SYSTEM AND CONTROLS

9.1 Gear drives:

9.1.1 Rotation frequency of the output shaft:

$$\frac{N_F}{N_A} = \frac{T_A \times T_C \times T_E}{T_B \times T_D \times T_F}$$

$$N_F = \frac{T_A \times T_C \times T_E}{T_B \times T_D \times T_F} \times N_A \quad \checkmark$$

$$N_F = \frac{30 \times 20 \times 50}{40 \times 60 \times 70} \times 2300 \quad \checkmark$$

$$= 410{,}71 \; r/\min \quad \checkmark$$

(3)

9.1.2 Velocity Ratio:

$$VR = \frac{N_{INPUT}}{N_{OUTPUT}}$$

$$= \frac{2300}{410{,}71} \quad \checkmark$$

$$= 5{,}6:1 \quad \checkmark$$

or

$$VR = \frac{N_{OUTPUT}}{N_{INPUT}}$$

$$= \frac{410{,}71}{2300} \quad \checkmark$$

$$= 1:0{,}178 \quad \checkmark$$

(2)

9.2 Belt Drives:

9.2.1 Rotation frequency of the driven pulley:

$$V = \pi D n \quad \checkmark\checkmark\checkmark$$

$$n = \frac{V}{\pi D}$$

$$= \frac{32}{\pi \times (0{,}26)}$$

$$n_{r/\min} = 39{,}18 \times 60$$

$$n_{r/\min} = 2350{,}6 \, r/\min$$

(3)

9.2.2 Tensile force in the tight side:

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

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

$$= 2{,}5 \times 140$$

$$= 350 \; N \quad \checkmark$$

(2)

9.2.3 Power transmitted:

$$P = (T_1 - T_2)v \quad \checkmark$$

$$P = (350 - 140) \times 32 \quad \checkmark$$

$$= 6720 \; Watts \quad \checkmark$$

(3)

9.3 **Hydraulics:**

9.3.1 **Fluid pressure:**

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

$$= \frac{\pi 0.02^2}{4}$$

$$= 0{,}31 \times 10^{-3}\ m^2 \quad \checkmark$$

$$p_A = \frac{F}{A_A} \quad \checkmark$$

$$= \frac{300}{0{,}31 \times 10^{-3}}\ Pa$$

$$= 967741{,}94\ Pa$$

$$= 0{,}97 \times 10^{6}\ Pa \quad \checkmark$$

$$= 0{,}97\ MPa$$

(4)

9.3.2 **Stroke at piston B:**

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

$$= \frac{\pi 0.075^2}{4}$$

$$= 4{,}42 \times 10^{-3}\ m^2 \quad \checkmark$$

$$V_B = V_A$$

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

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

$$= \frac{\left(0{,}31 \times 10^{-3}\right) \times 185}{4{,}42 \times 10^{-3}}$$

$$= 12{,}98\ mm \quad \checkmark$$

(4)

9.4 **Traction control:**
It prevents the wheels from spinning ✓ ✓ (2)

9.5 **Safety belt:**
Safety belts need to be activated (buckle up) by the driver/passenger ✓ ✓ (2)

[25]

QUESTION 10: TURBINES

10.1 **Water turbine:**

- Waterwheel ✓
- Pelton ✓
- Turgo ✓
- Michell-Banki ✓
- Jonval turbine ✓
- Reverse overshot waterwheel ✓
- Archimedes' screw turbine ✓

(Any 1x1) (1)

10.2 **Runaway speed of a water turbine:**
Runaway speed of a water turbine is its speed at full flow ✓ and with no shaft load ✓ (2)

10.3 **Water turbine:**

10.3.1 **Type of turbine:**

- Reaction turbine ✓
- Kaplan turbine ✓

(Any 1x1) (1)

10.3.2
A. Wicket gate ✓
B. Rotor ✓
C. Stator ✓
D. Shaft ✓
E. Water flow ✓
F. Blades ✓ (6)

10.3.3 **Advantages of water turbine:**

- Water turbine blades continue to turn on cloudy windless days unlike sun and windy system. ✓
- No water is consumed in this process ✓
- More reliable ✓
- Environmentally friendly with no pollution ✓
- More economical than steam turbines ✓
- Can be mounted vertically to take up less space ✓

(Any 3x1) (3)

10.4 **Function of turbo and superchargers:**
To increase ✓ volumetric efficiency ✓ of an internal combustion engine. (2)

10.5 **Compressor used in a turbocharger:**
Centrifugal ✓ (1)

10.6 **Turbocharger:**
Exhaust gasses ✓ (1)

10.7 **Advantage of a turbocharger:**

- It is driven by exhaust gasses ✓
- No power from engine is used ✓
- Power loss above sea level is eliminated ✓
- More power is developed compared to a similar vehicle without a turbocharger ✓
- Less fuel is used compared to engine mass ✓
- To increase volumetric efficiency ✓

(Any 1x1) (1)

10.8 **Advantage of a steam turbine:**

- It is compact ✓
- No lubrication is needed ✓
- It is more economical ✓
- Converts heat energy into mechanical energy ✓
- Greater thermal efficiency ✓
- Direct drive ✓
- Low maintenance ✓
- High power to weight ratio ✓

(Any 2x1) (2)

[20]

GRAND TOTAL: 200