



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY**

**FEBRUARY/MARCH 2015**

**MEMORANDUM**

**MARKS: 200**

**This memorandum consists of 18 pages.**

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

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

**[20]**

**QUESTION 2: SAFETY**

- 2.1 **Surface Grinder:**
- Make sure the sparks are of no danger to co-workers. ✓
  - Do not force the grinding wheel onto the material. ✓
  - Bring the grinding wheel slowly into contact with the material. ✓
- (3)
- 2.2 **Pressure Gauge:**
- To make sure there is no leakages. ✓
  - To make sure that the readings are accurate. ✓
- (2)
- 2.3 **Spot Welding:**  
To prevent the tips from overheating during operation. ✓
- (1)
- 2.4 **Cylinder Leakage test::**
- 2.4.1 **Stroke:**  
The beginning of compression stroke ✓
- (1)
- 2.4.2 **Piston:**  
Bottom dead centre ✓
- (1)
- 2.4.3 **Valves:**  
Both valves are closed ✓
- (1)
- 2.5 **Bearing Puller:**  
Perpendicular/90° to the bearing. ✓
- (1)
- [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. ✓

**OR**

- Credit should be given to the learner for the drawing illustrating the correct answer. (2)

**3.2 Beam bending and cylinder leakage tests:**

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

3.2.2 A cylinder leakage tester is to check whether **gasses leak** ✓ from the **cylinders**. ✓ (2)

**3.3 Compression Test:**

The rings are worn out. ✓✓ (2)

**3.4 Compression tester:**

- A – Spark plug adaptor ✓
- B – Pressure gauge ✓
- C – Pressure release valve ✓
- D – Rubber pipe ✓

(4)

**[12]**

**QUESTION 4: MATERIALS****4.1 Properties of structures:**

- 4.1.1
- Soft ✓
  - Ductile ✓
  - Grey or white in colour ✓

**(Any 2x1)** (2)

- 4.1.2
- Ductile ✓
  - Hard ✓
  - Strong and tough ✓
  - Resistant to deformation ✓

**(Any 2x1)** (2)

4.2 Cementite ✓✓

(2)

**4.3 Classes of steel**

4.3.1 Bolts, nuts, screws and rivets ✓

**(Any 1x1)** (1)

4.3.2 Surface hardening (case hardened), hardening and tempering ✓

**(Any 1x1)** (1)

4.3.3 Brittle, poor weldability ✓

**(Any 1x1)** (1)

**4.4 Definition:**

4.4.1 **Lower Critical point ( $AC_1$ ):**

This is the lowest temperature to which steel must be heated to be hardened. ✓✓

(2)

4.4.2 **Critical temperature:**

It is the temperature where a structural change takes place. ✓✓

(2)

**[13]**

**QUESTION 5: TERMINOLOGY****5.1 V-Screw thread cutting :**

- Set up the work-piece in the lathe and turn the part to be threaded to the major diameter of the thread. ✓
- Set the compound slide 30° to the right and set the tool up accurately in the post ✓
- Set the quick-change gearbox for 1,5 mm pitch ✓
- Start the lathe and set the cutting tool so that it just touches the work-piece. Set graduated dials to zero (cross feed and compound slide) ✓
- Move cutting tool a short distance off end of work-piece and feed compound slide say 0,06 mm inwards. ✓
- With lathe turning, engage half nuts at the correct line on the chasing dial, putting the first cut in progress ✓
- Withdraw the cutting tool quickly at the end of the cut and disengage the half-nut lever. Return the carriage to the starting point of the thread. ✓
- Stop the centre lathe and check with thread gauge to see if thread pitch is correct. ✓
- Repeat with successive cuts until thread is complete. (Remember to bring cross-feed collar back to zero for each cut). ✓
- Each successive cut is set by means of the compound slide. ✓
- Check thread with ring gauge for correct fit. ✓

(11)

**5.2 Cutting depth:**

$$\begin{aligned} \text{Cutting depth} &= 0,866 \times P && \checkmark \\ &= 0,866 \times 2,5 && \checkmark \\ &= 2,17 \text{ mm} && \checkmark \end{aligned}$$

(3)

**5.3 Indexing:**

$$\begin{aligned} \text{Indexing} &= \frac{40}{n} && \checkmark \\ &= \frac{40}{82} && \\ &= \frac{20}{41} && \checkmark \end{aligned}$$

No full turns. 20 holes on a 41 hole circle

✓

(3)

5.4 **Key calculations:**

5.4.1 **Key length:**

Length = 1.5 × Diameter ✓

Diameter =  $\frac{L}{1.5}$  ✓

Diameter =  $\frac{102}{1.5}$  ✓

Diameter = 68 mm ✓ (3)

5.4.2 **Key width:**

Width =  $\frac{D}{4}$  ✓

=  $\frac{68}{4}$  ✓

Width = 17 mm ✓ (3)

5.4.3 **Key thickness:**

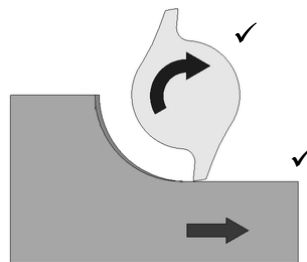
Thickness =  $\frac{D}{6}$  ✓

=  $\frac{68}{6}$  ✓

Thickness = 11.33 mm ✓ (3)

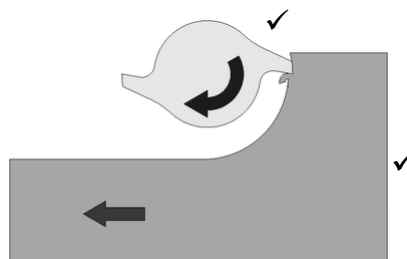
5.5 **Milling operations:**

**Up-cut milling:**



(2)

**Down-cut milling:**



(2)  
[30]

**QUESTION 6: JOINING METHODS****6.1 Welding Machine:**

6.1.1 MIGS/MAGS welding machine ✓ (1)

6.1.2 A. Welding pistol/gun ✓  
B. Switch ✓  
C. Regulator or Gas flow meter ✓  
D. Gas cylinder ✓  
E. MIGS/MAGS welding machine ✓  
F. Earth cable ✓  
G. Welding pistol conduit/welding hose ✓ (7)

**6.2 Operating principles of an X-ray testing equipment:**

- The X-ray source is placed in front of the object being tested. ✓
- The source is activated for a brief moment and the X-rays penetrate the test piece. ✓
- As the X-rays pass through areas of lower density, it will be exposed lighter on the film, which indicates the welding defects. ✓✓
- A photographic film with details of defects is provided, which can be studied. ✓✓ (6)

**6.3 Advantages of metal-arc shielded welding (MIGS/MAGS):**

- Can weld in any position ✓
  - Less operator skills are required ✓
  - Long welds can be made without stops and starts ✓
  - Minimal post welding cleaning is required ✓
- (Any 3x1) (3)**

**6.4 Bend test:**

- To measure ductility of the weld deposit and the heat affected area adjacent to the weld. ✓✓ (2)

**6.5 Welding defects:****6.5.1 Incomplete penetration:**

- Welding speed too high ✓
  - Joint design faulty ✓
  - Arc is too long ✓
  - Current too low ✓
- (Any 2x1) (2)**

**6.5.2 Welding craters:**

- Current too high ✓
  - Incorrect welding technique ✓
  - Electrode too thin ✓
- (Any 2x1) (2)**



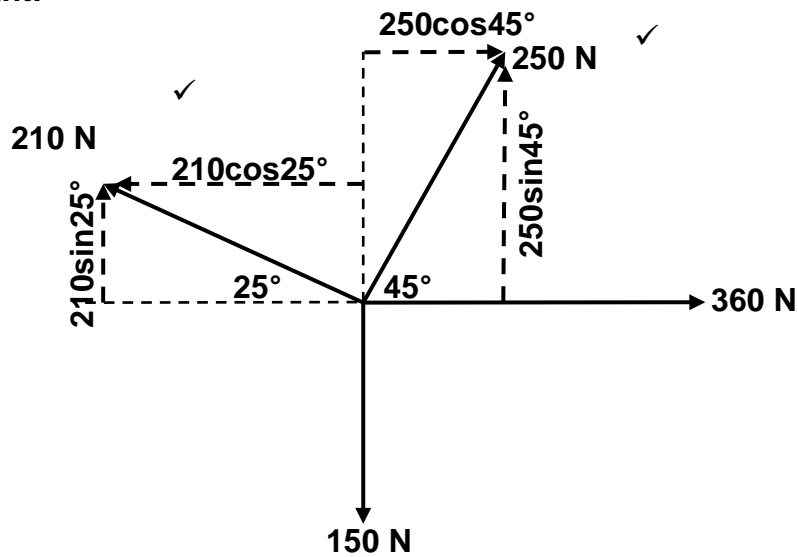
6.6 **Welding techniques:**

- Rate of electrode burning and progress of the weld ✓
- The angle of the electrode ✓
- The distance between the parent metal and the electrode.  
(Arc length) ✓

**(Any 2x1)****(2)  
[25]**

**QUESTION 7: FORCES**

**7.1 Equilibrant:**

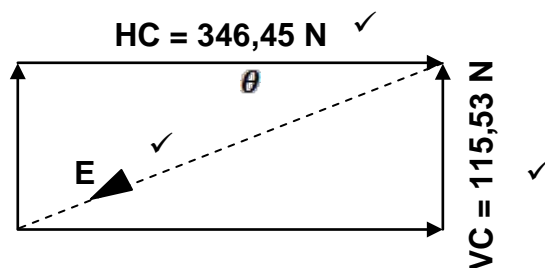


$$\begin{aligned} \Sigma HC &= 360 + 250\cos 45^\circ - 210\cos 25^\circ && \checkmark \checkmark \\ &= 346,45\text{N} && \checkmark \end{aligned}$$

$$\begin{aligned} \Sigma VC &= 250\sin 45^\circ + 210\sin 25^\circ - 150 && \checkmark \checkmark \\ &= 115,53\text{N} && \checkmark \end{aligned}$$

OR

HORIZONTAL COMPONENT	MAGNITUDES	VERTICAL COMPONENT	MAGNITUDES
$-210 \cos 25^\circ \checkmark$	-190,32N	$210 \sin 25^\circ \checkmark$	88,75 N
$250 \cos 45^\circ \checkmark$	176,78N	$250 \sin 45^\circ \checkmark$	176,78 N
360	360 N	-150	-150 N
<b>TOTAL</b>	<b>346,45 N</b> $\checkmark$	<b>TOTAL</b>	<b>115,53 N</b> $\checkmark$



$$E^2 = HC^2 + VC^2 \quad \checkmark$$

$$E = \sqrt{346,45^2 + 115,53^2} \quad \checkmark$$

$$E = 365,21 \text{ N} \quad \checkmark$$

$$\text{Tan } \Phi = \frac{VC}{HC} \quad \checkmark$$

$$= \frac{115,53}{346,45} \quad \checkmark$$

$$\Phi = 18,44^\circ \quad \checkmark$$

$$E = 365,21 \text{ N at } 18,44^\circ \text{ south from west} \quad \checkmark$$

(15)

## 7.2 Stress and Strain:

### Stress:

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

$$A = 0,1^2$$

$$A = 0,01 \text{ m}^2 \quad \checkmark$$

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

$$b = \frac{80 \times 10^3}{0,01} \quad \checkmark$$

$$b = 8 \times 10^6 \text{ Pa} \quad \checkmark$$

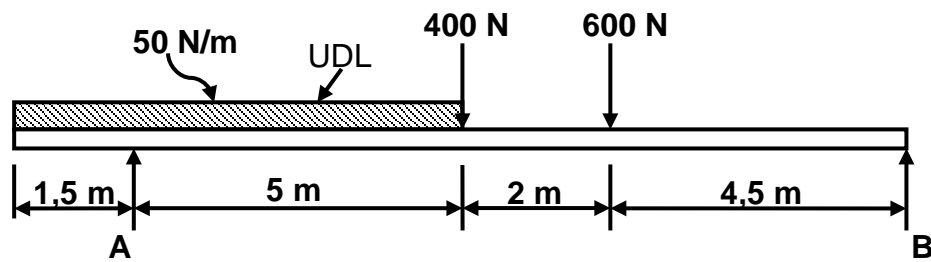
$$b = 8 \text{ MPa} \quad \checkmark$$

(5)

7.3 **Strain is directly proportional** ✓ **to the stress** ✓ **that causes it, provided the limit of elasticity is not exceeded** ✓.

(3)

## 7.4 Moments:



Calculate A

Take moments about 'B'

$$A \times 11,5 = (600 \times 4,5) + (400 \times 6,5) + (325 \times 9,75) \quad \checkmark \checkmark$$

$$= 2700 + 2600 + 3168,75$$

$$= 8468,75 \text{ N} \quad \checkmark$$

$$A = \frac{8468,75}{11,5}$$

$$A = 736,41 \text{ N} \quad \checkmark$$

Calculate B

Take moments about "A"

$$B \times 11,5 = (325 \times 1,75) + (400 \times 5) + (600 \times 7) \quad \checkmark$$

$$= 568,75 + 2000 + 4200$$

$$= 6768,75 \text{ N} \quad \checkmark$$

$$B = \frac{6768,75}{11,5} \quad \checkmark$$

$$B = 588,59 \text{ N}$$

(7)  
[30]

**QUESTION 8: MAINTENANCE****8.1 Advantages of cutting fluid:**

- The workpiece and cutting tool are kept cool. ✓
- The life of the cutting tool is prolonged. ✓
- A better finish is imparted to the workpiece. ✓
- Cuttings are washed away. ✓
- The worker is protected from very fine metal chips and dust. ✓
- It prevents corrosion. ✓
- Productivity is increased because the cutting process is faster. ✓

**(Any 2x1)** (2)

8.2 Preventive maintenance is maintenance of equipment and systems before faults occur. ✓ (1)

**8.3 Chain drive:****8.3.1 Chain drive preferable to belt drive:**

- It is much stronger ✓
- It has a much longer service life ✓
- It provides positive drive. (No slip) ✓

**(Any 2x1)** (2)**8.3.2 Stretched chain:**

- The chain loses its strength/tension. ✓
- It generates more friction. ✓
- It causes the chain to vibrate. ✓
- It causes excessive noise. ✓
- The chain can break. ✓
- The chain can easily slip from its sprocket. ✓

**(Any 2x1)** (2)**8.3.2 Chain Replacement:**

- Align crankshaft and camshaft pulleys before removing the timing chain. ✓
- Disconnect the link plate. ✓
- Remove the chain from the sprockets. ✓
- Select the correct length and size replacement chain. ✓
- Fit the new chain. ✓
- Insert the link plate and tension the chain. ✓

(6)

8.4 Engine oil must have a high flash point to prevent the vapour to ignite. ✓✓ (2)

**[15]**

**QUESTION 9: SYSTEM AND CONTROLS****9.1 Gear drives:****9.1.1 Number of teeth on idler gear:**

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

$$T_B = \frac{T_A \times N_A}{N_B} \quad T_B \times N_B = T_A \times N_A \quad \checkmark$$

$$T_B = \frac{50 \times 660}{1000}$$

$$T_B = 33 \text{ teeth} \quad \checkmark$$

(3)

**9.1.2 Rotation frequency of the driven gear:**

$$N_C \times T_C = N_A \times T_A \quad \checkmark$$

$$N_C = \frac{N_A \times T_A}{T_C} \quad \checkmark$$

$$N_C = \frac{660 \times 50}{60} \quad \checkmark$$

$$N_C = \frac{550 \text{ rpm}}{60} \quad \checkmark$$

$$N_C = 9,17 \text{ r/s} \quad \checkmark$$

(3)

**9.2 Belt Drives:****9.2.1 Rotation frequency of the driven pulley:**

$$N_{DN} \times (D_{DN} + t) = N_{DR} \times (D_{DR} + t) \quad \checkmark$$

$$N_{DN} = \frac{N_{DR} \times (D_{DR} + t)}{(D_{DN} + t)} \quad \checkmark$$

$$N_{DN} = \frac{1640 \times (175 + 12)}{(80 + 12)} \quad \checkmark$$

$$N_{DN} = \frac{3333,48 \text{ rpm}}{60} \quad \checkmark$$

$$N_{DN} = 55,56 \text{ r/s} \quad \checkmark$$

(3)

**9.2.2 Belt speed:**

$$v = \frac{\pi(D + t)N}{60} \quad \checkmark$$

$$v = \frac{\pi(0,175 + 0,012) \times 1640}{60} \quad \checkmark$$

$$v = 16,06 \text{ m/s} \quad \checkmark$$

(3)

9.3 **Hydraulics:**9.3.1 **Fluid pressure:**

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

$$A_A = \frac{240}{211618,76}$$

$$A_A = 1,13 \times 10^{-3}$$

✓

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

✓

$$p = \frac{240}{1,13 \times 10^{-3}}$$

$$p = 211618,76 \text{ Pa}$$

✓

(3)

9.3.2 **Force exerted by piston B:**

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

✓

$$A_B = \frac{\pi(0,15)^2}{4}$$

$$A_B = 0,017671458 \text{ m}^2$$

✓

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

✓

$$F_B = P \times A$$

$$F_B = (211618,76) \times (0,017671458)$$

$$F_B = 3739,61 \text{ N}$$

✓

(4)

9.4 **Purpose of vehicle engine management system:****The vehicle engine management system controls the...**

- Engine fuel system ✓
- Ignition system ✓
- Exhaust emission ✓
- Cooling system ✓
- Battery charging system ✓

**(Any 4x1)****(4)**

**9.5 Purpose of anti-lock brake system:**

ABS relieves hydraulic pressure on wheels which are about to skid. ✓ This action reduces the braking effort that would have caused a skid. ✓

**OR**

The purpose is to provide safer vehicle handling ✓ under difficult conditions. ✓

(2)  
**[25]**



**QUESTION 10: TURBINES****10.1 Water turbine:**

- Water turbines do not emit carbon. ✓
- No water is destroyed in the process of creating electricity. ✓
- Water turbines are more reliable. ✓
- Water turbines continue to turn on cloudy and windless days unlike solar and wind operated generators. ✓
- Environmental friendly and no pollution. ✓

(Any 2x1) (2)

**10.2 Water turbine definitions:**

10.2.1 Specific speed of a water turbine is the speed at which the turbine turns for a particular discharge with the unit head, and thereby is able to produce unit power. ✓✓ (2)

10.2.2 Free load/runaway speed of a water turbine is its speed at full flow and with no shaft load. ✓✓ (2)

10.3 A steam turbine is a mechanical device that extracts thermal energy from pressurised steam and converts it into useful mechanical work. ✓✓ (2)

**10.4 Classification of steam turbine:**

- Condensing turbines ✓
- Non-condensing turbines ✓
- Reheat turbines ✓
- Extraction turbines ✓
- Induction turbines ✓

(Any 3x1) (3)

**10.5 Gas turbine for naval vessels:**

It is valued for their high power to weight ratio which has quick acceleration as result. ✓✓ (2)

**10.6 Turbo boost:**

Turbo boost refers to the increase in manifold pressure that is generated by turbocharger in the intake path or specifically intake manifold that exceeds atmospheric pressure ✓✓ (2)

**10.7 Operation of twin-screw supercharger:**

- A twin screw supercharger operates by pulling air through a pair of meshing lobes that resemble set of worm gears.✓
- The air inside a twin screw supercharger is trapped in pockets created by the rotor blades.✓
- A twin screw supercharger compresses the air inside rotor housing.✓
- Reason is the rotors have a conical taper which means the air pockets decrease in size as air moves from the fill side to the discharge side.✓
- As the air pockets shrink, the air is squeezed into a smaller space and increases the pressure.✓

(5)  
**[20]****GRAND TOTAL: 200**