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:**

$$\text{Cutting depth} = 0{,}866 \times P \quad ✓$$
$$= 0{,}866 \times 2{,}5 \quad ✓$$
$$= 2{,}17 \text{ mm} \quad ✓$$

(3)

5.3 **Indexing:**

$$\text{Indexing} = \frac{40}{n} \quad ✓$$
$$= \frac{40}{82}$$
$$= \frac{20}{41} \quad ✓$$

No full turns. 20 holes on a 41 hole circle ✓ (3)

5.4 **Key calculations:**

5.4.1 **Key length:**

$$\text{Length} = 1.5 \times \text{Diameter} \quad ✓$$

$$\text{Diameter} = \frac{L}{1.5} \quad ✓$$

$$\text{Diameter} = \frac{102}{1.5}$$

$$\text{Diameter} = 68\,\text{mm} \quad ✓$$

(3)

5.4.2 **Key width:**

$$\text{Width} = \frac{D}{4} \quad ✓$$

$$= \frac{68}{4} \quad ✓$$

$$\text{Width} = 17\,\text{mm} \quad ✓$$

(3)

5.4.3 **Key thickness:**

$$\text{Thickness} = \frac{D}{6} \quad ✓$$

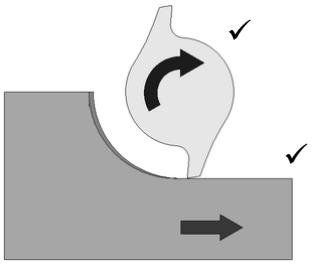
$$= \frac{68}{6} \quad ✓$$

$$\text{Thickness} = 11.33\,\text{mm} \quad ✓$$

(3)

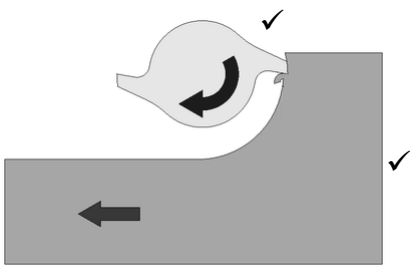
5.5 **Milling operations:**

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 to long ✓
- Current too low ✓

(Any 2x1) (2)

6.5.2 **Welding craters:**
- Current too high ✓
- Incorrect welding technique ✓
- Electrode too thin ✓

(Any 2x1) (2)

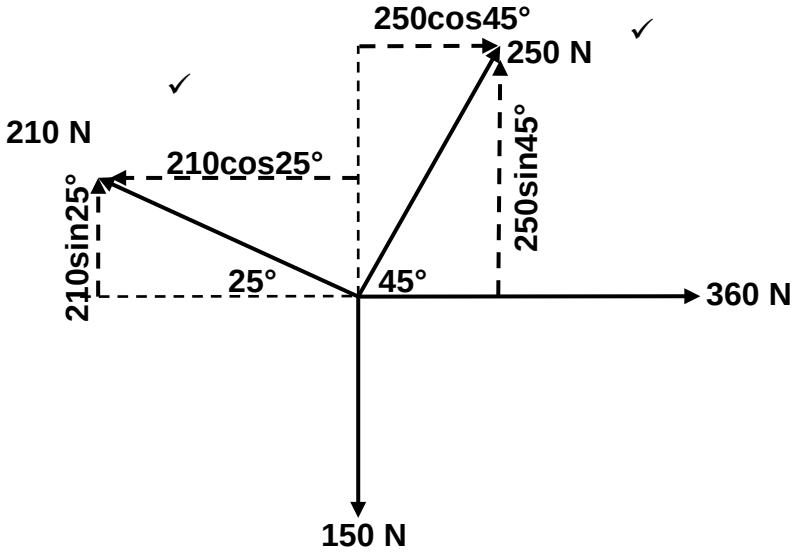
6.6 **Welding techniques:**

- 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:**

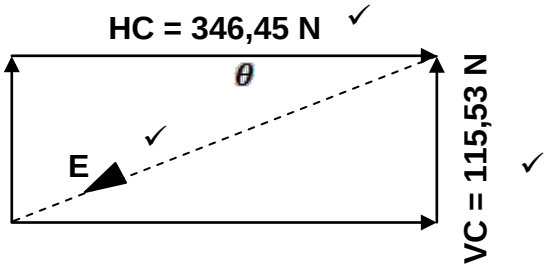


$$\sum HC = 360 + 250\cos45° - 210\cos25°$$ ✓✓
$$= 346,45\,N$$ ✓

$$\sum VC = 250\sin45° + 210\sin25° - 150$$ ✓✓
$$= 115,53\,N$$ ✓

OR

HORIZONTAL COMPONENT	MAGNITUDES	VERTICAL COMPONENT	MAGNITUDES
$-210\cos25^0$ ✓	-190,32N	$210\sin25^0$ ✓	88,75 N
$250\cos45^0$ ✓	176,78N	$250\sin45^0$ ✓	176,78 N
360	360 N	-150	-150 N
TOTAL	**346,45 N** ✓	**TOTAL**	**115,53 N** ✓



$$E^2 = HC^2 + VC^2 \quad \checkmark$$
$$E = \sqrt{346,45^2 + 115,53^2} \quad \checkmark$$
$$E = 365,21 \text{ N} \quad \checkmark$$

$$\text{Tan}\,\theta = \frac{VC}{HC} \quad \checkmark$$
$$= \frac{115,53}{346,45} \quad \checkmark$$
$$\theta = 18,44^0 \quad \checkmark$$
$$E = 365,21 \text{ N at } 18,44^0 \text{ south from west} \quad \checkmark$$

(15)

7.2 **Stress and Strain:**

Stress:

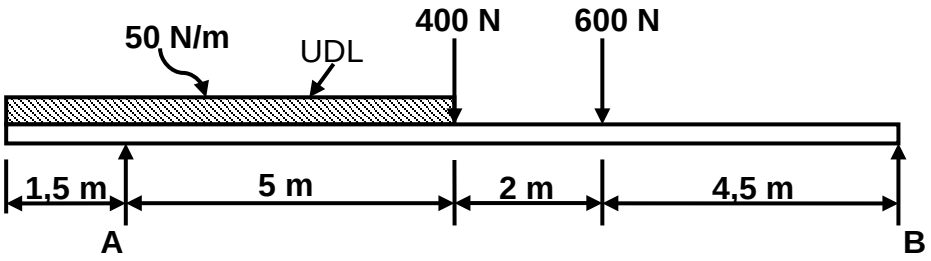
$$A = L^2 \quad \checkmark$$
$$A = 0,1^2$$
$$A = 0,01 \text{ m}^2 \quad \checkmark$$

$$\sigma = \frac{F}{A} \quad \checkmark$$
$$\sigma = \frac{80 \times 10^3}{0,01} \quad \checkmark$$
$$\sigma = 8 \times 10^6 \text{ Pa} \quad \checkmark$$
$$\sigma = 8 \text{ MPa}$$

(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'

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

$= 2700 + 2600 + 3168,75$

$= 8468,75 \ \ N$ ✓

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

$A = 736,41 \ \ N$ ✓

Calculate B
Take moments about "A"

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

$= 568,75 + 2000 + 4200$ ✓

$= 6768,75 \ \ N$

$B = \frac{6768,75}{11,5}$ ✓

$B = 588,59 \ \ N$ (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:

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

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

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

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

(3)

9.1.2 Rotation frequency of the driven gear:

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

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

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

$$N_C = \frac{550\,\text{rpm}}{60}$$

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

(3)

9.2 Belt Drives:

9.2.1 Rotation frequency of the driven pulley:

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

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

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

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

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

(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:**

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

$$A_A = \frac{\pi(0,038)^2}{4}$$

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

$$p = \frac{F_A}{A_A} \quad \checkmark$$

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

$$p = 211618,76 \text{ Pa} \quad \checkmark \qquad (3)$$

9.3.2 **Force exerted by piston B:**

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

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

$$A_B = 0,017671458 \ m^2 \quad \checkmark$$

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

$$F_B = P \times A$$

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

$$F_B = 3739,61 \ N \quad \checkmark \qquad (4)$$

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