education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY

MEMORANDUM

EXEMPLAR 2008

TIME: 3 hours

MARKS: 200

This memorandum consists of 21 pages

QUESTION 1: MULTIPLE CHOICE QUESTIONS

(Learning Outcome 3: Assessment Standards 1 – 9)

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

QUESTION 2: FORCES AND SYSTEMS AND CONTROL

(Learning Outcome 3: Assessment Standards 6 and 8)

2.1.1 STRESS AND STRAIN

$$Area = \frac{\pi d^2}{4}$$
$$= \frac{\pi x(0,024)^2}{4}$$
$$= 4,525x10^{-4}\,m^2 \quad \surd$$

$$Stress = \frac{Force}{Area}$$
$$= \frac{60x10^3}{4,525x10^{-4}} \quad \surd$$
$$= 132,579x10^6\,Pa$$
$$= 132,58MPa \quad \surd$$

(3)

2.1.2
$$Strain = \frac{change\ in\ length}{original\ length}$$
$$= \frac{0,22x10^{-3}}{212x10^{-3}} \quad \surd$$
$$= 1,038x10^{-3}$$
$$= 1,04x10^{-3} \quad \surd$$

(2)

2.1.3
$$Young's\ modulus\ of\ Elasticity\ (E) = \frac{Stress}{Strain}$$
$$= \frac{132,58x10^6}{1,04x10^{-3}} \quad \surd$$
$$= 127,48x10^9$$
$$= 127,48GPa \quad \surd$$

(2)

2.1.4 Young's' Modulus on softer materials will decrease or be lower than harder materials √√

(2)

2.2 BELT DRIVES

2.2.1 Belt length in an open belt drive

$$Length = \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} + 2C$$

$$= \frac{\pi(600+300)}{2} + \frac{(600-300)^2}{4(850)} + 2(850) \quad \surd$$

$$= \frac{\pi(900)}{2} + \frac{(90000)}{3400} + 1700 \quad \surd$$

$$= 3139,47\ mm \quad \surd$$

(3)

2.2.2

For maximum power transmission the belt drive will have to be shorter √

Belt length in an cross belt drive

$$Length = \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C} + 2C$$

$$= \frac{\pi(600+300)}{2} + \frac{(600+300)^2}{4(850)} + 2(850)$$

$$= \frac{\pi(900)}{2} + \frac{(810000)}{3400} + 1700$$

$$= 3351,24\ mm \quad \surd$$

I would therefore recommend the open belt drive √ (3)

2.3 TORQUE

$$Power = \frac{2\pi NT}{60}$$

$$Torque = \frac{Power\ x\ 60}{2\pi N} \quad \surd$$

$$= \frac{6000\ x\ 60}{2\ x\ 3,142\ x\ 1500}$$

$$= 38,19Nm \quad \surd$$

(3)

The motor that is available will satisfy the requirements of Mrs Realeboga because it is producing a torque of 40 Nm which is slightly more than the required torque √

2.4 HYDRAULICS

2.4.1 APPLIED FORCE AT POINT A

First calculate pressure. Note pressure at point A = pressure at B

$$\begin{aligned} Pressure\ at\ B\ (P_B) &= \frac{Load(F)}{A_B} \\ &= \frac{800}{0,16} \quad \surd \\ &= 5\ 000\ Pa \quad \surd \\ &= 5\ kPa \end{aligned}$$

$$NOTE\ P_A = P_B$$

$$\begin{aligned} F_A &= P_A\ x\ A_A \\ &= 5000\ x\ 0,015 \quad \surd \\ &= 75N \quad \surd \end{aligned}$$

(4)

2.4.2 TO CALCULATE THE STROKE LENGTH IN POINT A

Note volume in cylinder **A** is equal to the volume in cylinder **B.**

$$\begin{aligned} V_B &= A_B\ x\ L_B \\ &= 0,16\ x\ 8\ x\ 10^{-3} \quad \surd \\ &= 0,00128\ m^3 \quad \surd \\ &= 1.28x10^{-3}\ m^3 \end{aligned}$$

$$NOTE: V_A = V_B$$

$$\begin{aligned} V_A &= A_A\ x\ L_A \\ 0,00128 &= 0,015\ x\ L_A \quad \surd \\ L_A &= \frac{0,00128}{0,015} \quad \surd \\ &= 0,08533\ m \quad \surd \\ &= 85.33\ mm \end{aligned}$$

(5)

2.4.3 EFFECT OF CHANGE IN LENGTH

If the length is increased there will no effect on the system √ The pressure will still be the same throughout the system and the same volume will be induced meaning the distance “x” will still be the same √

(2)

2.4.4 EXAMPLE WITH ANOTHER SYSTEM

The hydraulic jack of a motor car is another example of this type of layout √√

(2)

2.5 WHEEL AND AXLE

2.5.1 To calculate the magnitude of the effort (F)

$$\text{Mechanical advantage } (M.A) = \frac{W}{F}$$

$$F = \frac{W}{M.A} \quad \surd$$

$$= \frac{1400}{4}$$

$$= 350\ N \quad \surd$$

(2)

2.5.2 To calculate the velocity ratio (VR)

$$VR = \frac{2D}{(d_1 - d_2)}$$

$$= \frac{2\ x\ 210}{160 - 130} \quad \surd$$

$$= \frac{420}{30}$$

$$= 14:1 \quad \surd$$

(2)

2.5.3 To calculate efficiency of the system

$$\eta = \frac{M.A\ x\ 100\%}{VR}$$

$$= \frac{4\ x\ 100}{14}$$

$$= 28,57\% \quad \surd$$

The efficiency of the system will remain the same because pulley A is a lever and does not affect the operation of the differential wheel and axle machine √

(2)

2.6 THREE-START SCREW THREAD

2.6.1 To calculate the helix angle

$$\tan\phi = \frac{Lead}{Pitch\ circumference}$$

$$But,\ Lead = pitch\ x\ number\ of\ starts$$
$$= 10\ x\ 3$$
$$= 30\ mm \quad \surd$$

$$And,\ Pitch\ diameter = Outside\ diameter - \frac{1}{2}\ pitch$$
$$= 55 - [\frac{1}{2}\ x\ 10]$$
$$= 55 - 5$$
$$= 50\ mm \quad \surd$$

$$Tan\ \phi = \frac{Lead}{Pitch\ circumference}$$
$$= \frac{30}{3{,}142\ x\ 50} \quad \surd$$
$$= 0{,}191$$
$$\phi = 10{,}81^0 \quad \surd$$

(4)

2.6.2 $Leading\ tool\ angle = 90^0 - (helix\ angle\ +\ clearance\ angle)$
$= 90^0 - (10{,}81^0 + 3^0)$ √
$= 90^0 - 13.81^0$
$= 76.19^0$ √

(2)

2.6.3 The farmer could use the four start square thread √
It is stronger √
Can be made smaller to save space √
They have more travel than a three start square thread √

(4)

2.7 FRICTION CLUTCH

Oil in the clutch plate √
Friction plate worn out √
Clutch plate spring lost its tension √

(3)

TOTAL (50)

QUESTION 3: TOOLS AND EQUIPMENT

(Learning Outcome 3: Assessment Standards 2)

3.1 BRINELL HARDNESS TESTER

1 - Hand pump √

2 – Plunger √

3 – Cylinder √

4 – Ball √

5 – Screw √

6 – Material under test √

7 – Ram √

8 – Force measure √ **(8 x ½ = 4)** (4)

3.2 GAS ANALYSER

Switch on the analyser and permit it to warm up for at least five minutes, then zero both meter needle indicators √

Allow the engine to attain its normal operating temperature and attach the sample probe well into the tail pipe √

Connect the tachometer to the engine's distributor √

Increase the engine speed to 2500 rpm and maintain it for at least 30 seconds then take both carbon monoxide (CO) and hydrocarbon (HC) readings √

Reduce the speed to idling for 10-20 seconds to enable readings to stabilise and then observe CO and HC readings √

If necessary adjust the mixture and idle speed screws to give the correct percentage CO exhaust content at a specified idle speed √

If emission readings still exceed the specifications, check the fuel supply system, ignition system and engine condition for the cause of high readings √

(7 x 1 = 7) (7)

3.3 **PRESSURE TESTER** is used to determine the test pressure of pressure vessels √

If there is a pressure drop after 20-30 minutes it means that there is a leakage in the valves or seams √ (6)

The tests are carried on vessels containing either air or fluids √

CYLINDER LEAKAGE TESTER is used to determine any leak through air intake valve, an exhaust valve, head or block and excessive leakage past the piston rings √

If there the tester shows a pressure drop after 20-30 minutes it means that there is a leakage in the cylinder √

The tests are carried out only on internal combustion engines √

3.4 USE OF MULTIMETERS

ANY THREE OF THE FOLLOWING

- Check that the measuring leads are inserted into the correct sockets for the measurement you wish to perform √
- Turn the function switch to the desired function (Volts, Amps or Ohms √
- If you do not know what size of reading to expect, it is good practice to always first switch to the highest range in that function √ (3)
- Connect the metres' measuring lead probes to the correct points in the circuit to be tested √

TOTAL (20)

QUESTION 4: MATERIALS

(Learning Outcome 3: Assessment Standards 3)

4.1 PROPERTIES OF MATERIALS

	Non-ferrous metal	Composition	Properties	Uses	Marks
4.1.1	Phosphor bronze	Tin and phosphorous √	Corrosion resistant √	hot, wet and corrosive conditions √	(3)
4.1.2	Duralumin	Copper and manganese √	high tensile strength √	Forgings and stampings √	(3)
4.1.3	Solder	Tin and lead √	Low melting point √	Soldering √	(3)
4.1.4	Silver solder	Copper and silver √	Low melting point	unions of petrol pipes for aircraft engines √	(3)

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4.2 TEFLON PROPERTIES

4.2.1 It has a high friction resistance √

4.2.2 It is very light in weight √

4.2.3 It is easy to handle √

4.2.4 It provides a smooth surface √

4.2.5 It is non-magnetic √

Any three (3 x 1 = 3) (3)

4.3 NYLON PROPERTIES

	No need for a lubricant	√	
	Maintenance free	√	
	Maintenance free	√	
	Low cost	√	
	Very light in weight	√	
	Easily machineable	√	
	Can withstand a lot of shock	√	
		Any three (3 x 1)	(3)
4.4	Polyvinyl Chloride	√√	(2)
		TOTAL	**(20)**

QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS

(Learning Outcome 3: Assessment Standards 1,4 and 5)

5.1 GRINDING MACHINE

Never use the machine without safety goggles √

Never use the machine without the guards being correctly fitted √

See that there is on oil or grease on the floor around the machine √

Check that the tool rest is not more than 3 mm from the grinding wheel √

When setting the machine in motion, never stand in front of the wheels √

Before grinding operation takes place, let it run idle for few seconds √

Unbalanced wheel to be dressed by an emery wheel dresser √

Never grind on the side of a straight wheel. Use various wheels only for the purpose for which they are made √

Never jab grinding matter on wheel, but approach with care for best results √

Never force grind so that the motor stops or slowed down excessively √

Never adjust the tool rest while the machine is running √

Work pieces and clamps should always be clamped safely and firmly √

Never let the wheel stand in cutting fluid as this will cause the wheel to become out of balance √

Make sure that the plug is fitted properly √

Check the wire connections regularly to prevent electrical short circuits √

(Any four 4 x 1 = 4) (4)

5.2 POWER SAW

Burrs on cut pieces are sharp. Use special care when handling pieces with burrs √

Do not clean chips from the machine with your hands. Use a brush. Stop the machine before attempting to clean it √

Keep your hands clear of moving parts √

Stop the machine before making adjustments √

Have any cuts and scratches, even though minor, treated promptly √

(Any four 4 x 1=4) (4)

5.3 OIL OR GREASE NEAR OXY-ACETYLENE CYLINDERS

Oil and grease are flammable and may cause fire √√ (2)

5.4 INDEXING

- Simple indexing √
- Rapid indexing √
- Angular indexing √
- Differential indexing √ (4)

5.5 INDEXING

INDEX PLATE HOLE CIRCLES											
Side 1	24	25	28	30	34	37	38	39	41	42	43
Side 2	46	47	49	51	53	54	57	58	59	62	66

STANDARD CHANGE GEARS											
	24 x 2	28	32	40	44	48	56	64	72	86	100

Simple indexing: Use N = 120

Indexing $= \frac{40}{120}$ √

$= \frac{8}{24}$ √ (2)

i.e. No full turns and eight holes in a twenty four hole circle but three divisions more were chosen

The following gear ratio $= (N - n)\ x\ \frac{40}{N}$

$= (120 - 117) x \frac{40}{120}$ √

$= 3x \frac{40}{120}$ √

$= \frac{1}{1}$ √

$= \frac{24}{24}$ √ (4)

0 *fullturns of the crank handle,* 8 *holes* √ *in a twenty four hole* √ *circle plate with a gear ratio of* $\frac{24}{24}$ √ *and the hole circle plate turning in the same direction* √ *as the crank handle.* (4)

5.6 GEAR TOOTH - LABEL

A – Addendum √

B – Dedendum √

C – Total depth √

D – Pitch circle √

E – Clearance √

F- Working depth √ (6)

5.7.1 INCOMPLETE PENETRATION

Faulty joint design	√	
Welding speed too rapid	√	
Insufficient welding current or nozzle size	√	
Too large an electrode or filler rod	√	
	(Any two 2 x 1 = 2)	(2)

CORRECTION METHOD FOR INCOMPLETE PENETRATION

Check root gap and root face	√	(1)

5.7.2 UNDERCUTTING

Current too high or nozzle too large	√	
Incorrect manipulation	√	
Arc length too long	√	
Welding speed too rapid	√	
	(Any two 2 x 1 = 2)	(2)

CORRECTION METHOD FOR UNDERCUTTING

Check angle so that arc force is used to fill undercut	√	(1)

5.7.3 CAUSE OF SLAG INCLUSION IN WELD

Joint design continues to narrow an included angle	√	
High viscosity of molten metal	√	
Rapid chilling	√	
Too low a weld temperature	√	
	(Any two 2 x 1 = 2)	(2)

CORRECTION METHOD FOR SLAG INCLUSION

Use preheat	√	
Remove slag from previous weld in multi-run welds	√	
	(Any one 1 x 1 = 1)	(1)

5.8 Nick break test is breaking the weld open √
to examine internal defects √

Nick bend test is used to test the skill of the welder in fusion, √
slag inclusion and severe porosity. √ (4)

5.9 LIQUID DYE PENETRANT INSPECTION

The liquid dye penetrant is sprayed onto the surface being inspected √

The liquid is allowed to penetrate for a short time √

The excess amount of dye is removed with a cleaner √

The surface is washed with water and allowed to dry √

After the surface is thoroughly dry, a developer is sprayed on the surface, which brings out the colour in the dye penetrant that has penetrated into any cracks or pin-holes √

Should the dye penetrant come up from the crack, it means there are welding flaws on the joint √

If the dye penetrant does not come up, it means the welded joint is good √

(7 x 1) (7)

TOTAL (50)

QUESTION 6: MAINTENANCE AND TURBINES

(Learning Outcome 3: Assessment Standards 7 and 9)

6.1 VISCOSITY (2)

Viscosity is the thickness and fluidity of oil or resistance of oil to flow √√

6.2 BEARING FAILURES

Insufficient lubrication √

Excessive lubrication √

Grease liquefaction √

Foaming oil √

Abrasive or corrosive contaminants in bearing √

Raceway turning on shaft or in housing √

Inadequate bearing clearances caused by being too tight on shaft or on housing √

Excessive clearance √

Contamination/dirt √

(Any 4 x 1 = 4) (4)

6.3 OIL SEALS

Oil seals are fitted to ensure that there are no oil leaks as different parts of an engine are being lubricated √√ (2)

6.4 OIL GRADES

6.4.1 SAE 30/40 √√ (2)

6.4.2 SAE 80/90 √√ (2)

6.4.3 ATF (Automatic transmission fluid) SAE 75-250 HD or EP √√ (2)

6.5 CUTTING FLUID

To keep the workpiece cool √

To keep the cutting tool cool √

To obtain a higher cutting speed √

It gives the cutting tool a longer lifespan √

There is a better finish on the workpiece when being machined √

Does not rust the machine √

Helps to wash away the chips of the metal being removed from the workpiece, thus keeping the cutting edge of the cutting tool clean √

(Any two 2 x 1 = 2) (2)

6.6 OIL CHANGE

(2)

Due to heat and friction the oil becomes weak and contaminated by metal particles √√

6.7 PROCEDURE OF CHANGING THE OIL IN A CAR

engine must be in normal operating temperature √

place an oil drainage container √

remove the oil filter cap √

remove the drain plug and allow oil to drain into container √

use a filter wrench and remove the old oil filter √

allow all oil to be drained out completely √

apply a film of oil on the oil seal of the filter and fit filter using hand √

fit drain plug with new washer and fill oil according to specification, replace filter cap √

Any 7 (7 x 1 = 7) (7)

6.8 THE PURPOSE AND FUNCTION OF THE ROOT BLOWER

It cleans the cylinder by forcing out exhaust gases. This operation is known as scavenging √

It provides clean air to help with the cooling of the cylinder, piston crown and valves √

It fills the cylinder with an air charge higher than atmospheric pressure √

(3 X 1 = 3) (3)

6.9 ENGINE AND BLOWER

6.9.1 Four stroke petrol engine equipped with a turbocharger √ (1)

6.9.2 1 = Air inlet √

2 = Turbocharger √

3 = Compressed air √

4 = Carburettor √

5 = Exhaust gases √

6 = Exhaust turbine √

(6 X 1 = 6) (6)

6.9.3 ADVANTAGES OF TURBOCHARGER

- More power is obtained from an engine with the same engine capacity √
- Engines with superchargers are more economical per given kilowatt output √
- Less fuel is used in proportion to engine capacity √
- The effect of height above sea level on power is eliminated √

(Any 2 x 1 = 2) (2)

6.10 OPERATION OF VANE TYPE BLOWER

By creating a vacuum air is taken in through the inlet port √

Air is then carried between the vanes and the housing to the outlet port √

As a result of the eccentric mounting of the rotor, the space is reduced and air is pushed out under pressure √

Any 3(3 x 1) (3)

TOTAL (40)

GRAND TOTAL [200]

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