education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

MECHANICAL TECHNOLOGY

EXEMPLAR PAPER 2007

MARKING MEMORANDUM

This memorandum consists of 14 pages.

INSTRUCTIONS AND INFORMATION

Question	Assessment Standards	Concepts covered	Marks	Time
1	1 – 9	Multiple choice questions	20	18 minutes
2	6 and 8	Applied Mechanics	50	45 minutes
3	2	Tools and equipment	20	18 minutes
4	3	Materials	20	18 minutes
5	1, 4 and 5	Manufacturing process, construction methods and safety	50	45 minutes
6	7 and 9	Pumps and maintenance	40	36 minutes
TOTAL			**200**	**180 minutes**

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 B √ (1)

1.5 A √ (1)

1.6 D √ (1)

1.7 C √ (1)

1.8 A √ (1)

1.9 B √ (1)

1.10 D √ (1)

1.11 A √ (1)

1.12 C √ (1)

1.13 D √ (1)

1.14 B √ (1)

1.15 A √ (1)

1.16 C √ (1)

1.17 B √ (1)

1.18 D √ (1)

1.19 D √ (1)

1.20 A √ (1)

[20]

QUESTION 2: APPLIED MECHANICS
(Learning Outcome 3: Assessment Standards 6 and 8)

2.1 Force "Y"

2.1.1 Clockwise moments = Anti-clockwise moments

$(Y \times 5.8) + (30 \times 2.8) = 60 \times 3.2$ √

$5.8Y + 84 = 192$ √

$5.8Y = 192 - 84$ √

$Y = \frac{108}{5.8}$ √

$= \mathbf{18.62N}$ √

(5)

2.1.2 Load on support = Total of all downward forces

Load = 60+30+18.62 √

= **108.62N** √

(2)

2.2 Bridge

2.2.1 Taking moments about point P:

$Q \times 10 = 650 \times 9 + 400 \times 5 + 500 \times 2$ √

$= 5850 + 2000 + 1000$

$= 8850$

Q = 885 N √

Taking moments about point Q:

$P \times 10 = 500 \times 8 + 400 \times 5 + 650 \times 1$ √

$= 4000 + 2000 + 1000$

$= 6650$

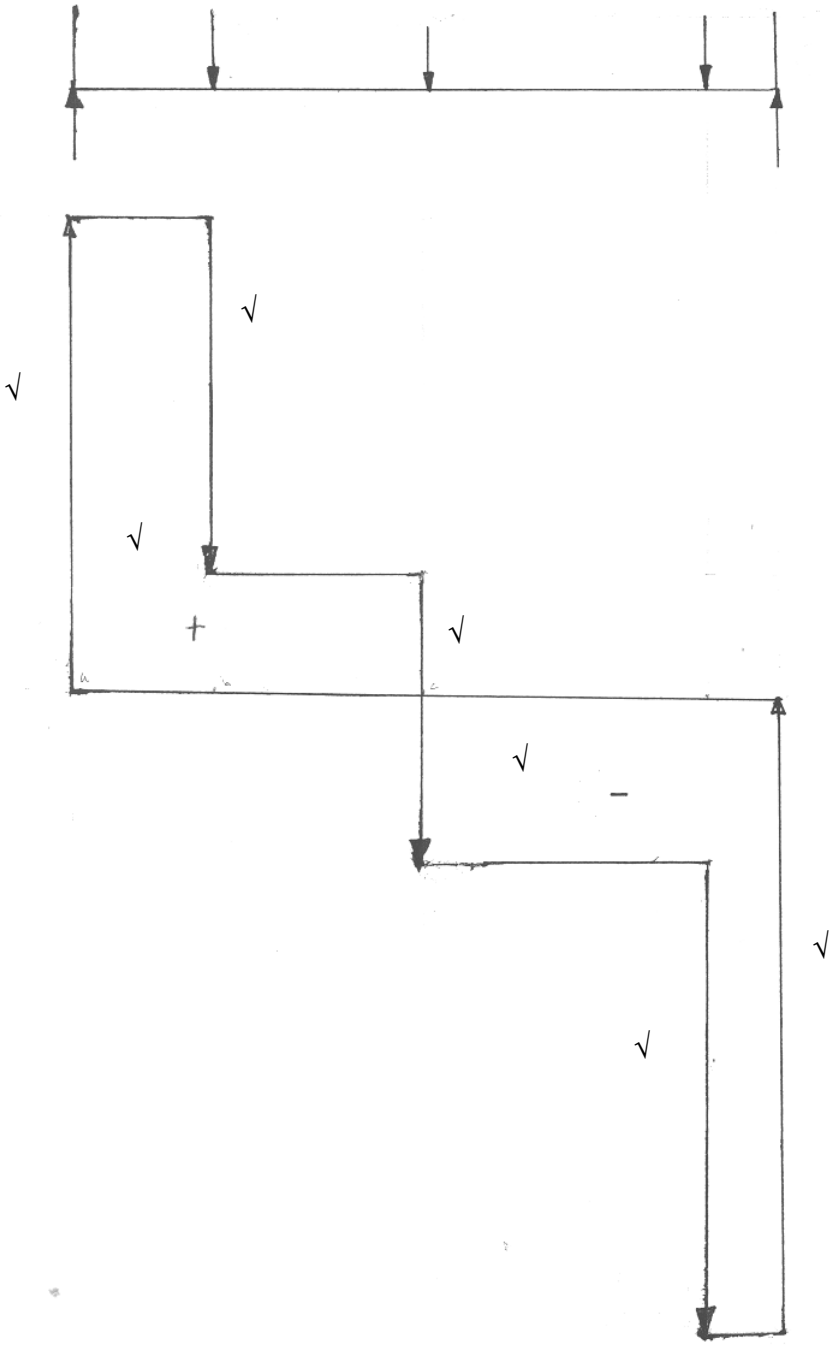
P = 665 N √

Total load = (885 + 665) / 10 (6)

= 155 kg √

The bridge is safe to be used as the maximum load that can be carry is 250 kg. √

2.2.2



(7)

2.3 Gear drives:

2.3.1 (a) Rack and pinion √
(b) Bevel gears √
(c) Worm and worm wheel √ (3)

2.3.2 (a) Rack and pinions are used in steering boxes of cars √√
(b) Bevel gears are used for tandem drives or double differential drives √√
(c) Worm and worm wheels are also used in steering boxes √√ (6)

2.4 Basic lifting machine - torque

2.4.1 Converting the mass into force:
F = mg √
= 10 x 10 √
= 100 N √

Converting mm to m:
$\frac{150 \text{ mm}}{1000}$ √
= 0.15 m √

Converting diameter to radius:
Radius = $\frac{\text{Diameter}}{2}$ √
= $\frac{0.15}{2}$
= 0.075 m √

Torque = Force x Radius √
= 100 x 0.075
= 7.5 Nm √√ (10)

2.5 Overhead crane braking system

2.5.1 Electromagnetic √ √ (2)

2.5.2 1= spiral spring √
2 = shaft √
3 = brake shoe √
4 = lever (B) √
5 = Electromagnetic solenoid √
6 = lever (A) √ (7)
7 = brake shoe √

2.5.3
- The system provides safe working conditions √ (2)
- It is a fast response system √

QUESTION 3: TOOLS AND EQUIPMENT
Learning Outcome 3: Assessment Standard 2)

3.1 Dial indicator:

3.1.1 1 = Rotating bezel and dial √
2 = Millimetre dial √
3 = Spigot √
4 = Plunger √
(4)

3.1.2 a) It is used to obtain correct measurement by comparing the item being measured with a known standard √
b) It could be used to check the roundness (concentricity) of objects √ (2)

3.2 Screw cutting

1 Use cutting paste
2 Use a square to set up the dies perpendicular √
3 Turn the die one full turn and a then a quarter of a turn back – repeat until finished. √ (2)

3.3 Inside micrometer reading

75
+ 10
+ 0.04 √
= 85.04 mm √ (2)

3.4 Wheel dresser – steps for using

- Adjust the work rest away from the wheel so that the heel of the dresser can hook over the work rest which guides it √
- Wear goggles or put on the eye shield √
- Start the machine and allow the grinder to attain full speed √
- Hook the heel of the dresser over the work rest and lift the handle slowly until the wheels of the dresser touch the grinding wheel √
- Hold the dresser firmly in position and move slowly across the face of the grinding wheel, lifting the handle slightly after each pass √
- Repeat this procedure until the wheel is clean and square √
- Keep the dresser moving to prevent grooves forming in the wheel √
- Adjust the work rest back so that it just clears the grinding wheel √ (8)

QUESTION 4: MATERIALS
(Learning Outcome 3: Assessment Standard 3)

4.1 Properties of steel

	COLUMN A	COLUMN B
4.1.1	Hardness	**B** √
4.1.2	Plasticity	**A** √
4.1.3	Conductivity	**D** √
4.1.4	Toughness	**C** √

(4)

4.2 Methods of enhancing the properties of steel

4.2.1 Annealing

Process of heat treatment by which certain metals and alloys are rendered less brittle and more resistant to fracture in order to restore the ductility of the metal lost because of work hardening during the forming operation. √ √

Annealing minimizes internal defects in the atomic structure of the material and leaves it free from internal stresses that might otherwise be present because of prior processing steps. √

Ferrous metals are annealed by heating them to high temperatures and cooling them slowly. √ √

Large masses of metal are cooled within the heating furnace; sheets are usually annealed in a continuous-process furnace. √ (6)

4.2.2 Case hardening

Hardening the surfaces of steel products in order to make them more resistant to abrasion and wear, while leaving the interior soft and therefore tougher and more fracture-resistant. The carbon usually dissolves in the steel to a depth of 0.3 to 3 mm, depending on the length of treatment. √ √

Case hardening is important in the manufacture of gears, axles, and other machine parts subject to much mechanical wear. √ √

The hardening may be accomplished by dissolving carbon into the surface. √ (5)

4.2.3 Tempering

Low-temperature process in the heat treatment of steel by which a desirable balance is obtained between the hardness and toughness of the finished product. √ √

Steel articles that have been hardened by quenching, a process of heating to about 870° C. √ √

And cooling rapidly in oil or water, become hard and brittle. √ (5)
[20]

QUESTION 5: MANUFACTURING PROCESS, CONSTRUCTION AND SAFETY (Learning Outcome 3: Assessment Standards 1, 4 and 5)

5.1 Safety precautions on a lathe

Any FIVE of the following:

5.1.1 Loose clothing are is not allowed √ (1)

5.1.2 Wear safety goggles √ (1)

5.1.3 Clamp the workpiece solidly √ (1)

5.1.4 Secure all the guards before starting a machine √ (1)

5.1.5 Keep the machine clear of tools √ (1)

5.1.6 Always remove the key from the chuck √ (1)

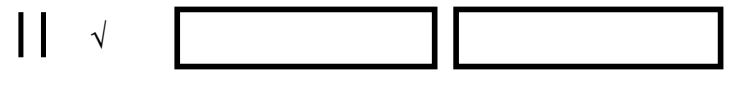
5.1.7 Stop the machine before you take measurements or make adjustments √ (1)

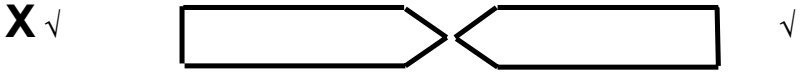
5.1.8 Do no put tools on the lathe sideways √ (1)

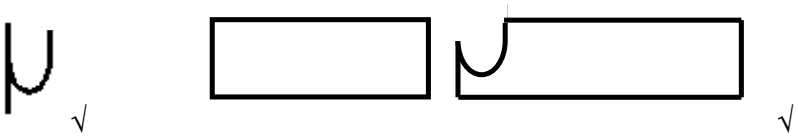
5.1.9 Never attempt to run the chuck on or off of spindle using power √ (1)

5.1.10 Stop the machine immediately if you hear an unusual noise or vibration √ (1)

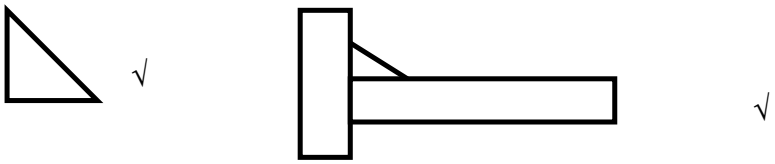
5.2 Welding joints

5.2.1  (2)

5.2.2  (2)

5.2.3  (2)

5.2.4  (2)

5.2.5  (2)

5.3 Soft and hard soldering

Soft soldering is the low temperature form of soldering √√ (2)

Hard soldering includes brazing and silver soldering which is a high temperature form of soldering. √√ (2)

5.4 Brazing

Any TWO of the following:

- Keep the metal clean during heating √
- They break down the surface tension of solder, enabling it to flow √
- Some fluxes, clean the metal to a limited extend √ (2)

5.5 Oxy-acetylene apparatus

- Close all pressure regulator valves √
- Open acetylene cylinder valves slowly √
- Open acetylene valve on the welded torch √
- Set the acetylene pressure on the regulator by turning the regulator valve clockwise and close the welding torch √
- Open the oxygen cylinder valve slowly √
- Open the oxygen valve on the welding torch √
- Set the oxygen pressure on the regulator by turning the regulator valve anti-clockwise and close the welding torch √ √
- The apparatus will now be ready for use √ (9)

5.6 Pneumatic and hydraulic symbols

5.6.1	Throttle valve	√	(1)
5.6.2	Shut off valve	√	(1)
5.6.3	Temperature gauge	√	(1)
5.6.4	Heat engine	√	(1)
5.6.5	Hydraulic flow	√	(1)
5.6.6	Electric motor	√	(1)
5.6.7	Pressure gauge	√	(1)

5.7 Screw thread on a centre lathe

5.7.1 Meaning of M 12 x 2:

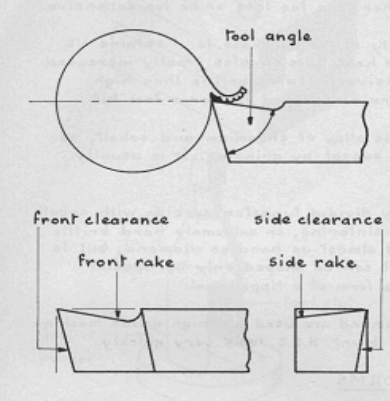
M = Metric √ (3)
12 = Diameter √
2 = pitch of thread √

5.7.2 Advantages of a three jaw chuck

Any TWO of the following:

- Can hold a wide range of hexagonal and cylindrical work pieces √
- There are jaws available for external and internal work √
- You can do work on the end face of the workpiece √ (2)
- You can easily mount the workpiece (self centering) √

5.7.3 Cutting tool - sharpening



(3)

5.7.4 Changes to the lathe:

- Set the compound slide to the angle of 60^{o} with reference to bed of the lathe√
- Place the cutting tool in the tool holder and set it center height √
- Set the cutting tool square to the axis of the work, using the center gauge √
- Set the lathe to a low speed
- Set the screw cut gearbox to a pitch of 2 mm.

(5)

QUESTION 6: PUMPS AND MAINTENANCE

6.1 Mechanical pump

A pump is a mechanical device that is used to raise a fluid from a lower to a higher level √ (1)

6.2 Types of pumps

- Centrifugal pumps √
- Rotary pumps √
- Reciprocating pumps √ (3)

6.3 Parts of a centrifugal pump

1 = Outlet √
2 = Impeller blades √
3 = Eye (Inlet) √
4 = Volute casing √ (4)

6.4 Lubrication terms

6.4.1 Viscosity is the fluidity and thickness of a liquid √√ (2)

6.4.2 Burning point is the temperature where the oil gives off enough vapour to burn continuously when ignited. √√ (2)

6.4.3 Flash point is the temperature where the oil gives off a vapour which, when mixed with air, forms a flammable mixture for a short period of time. √√ (2)

6.5 Single action pump

6.5.1 1 = Plunger √
2 = Outlet valve √
3 = Inlet valve √
4 = Cylinder √ (4)

6.5.2 Difference between single and double action pumps

- The single acting pump delivers a small amount of volume that is present in the cylinder every stroke. Only one inlet valve and delivery valve is required. √√
- The double acting pump delivers twice the amount of liquid that a single acting pump can deliver at each stroke. Liquid is drawn into the pump on one side of the cylinder. √√ (4)

6.6 Gear pump

- A gear pump develops flow by carrying fluid between the teeth of two meshed gears √
- A partial vacuum is created at the inlet as the gears un-mesh
- Fluid flows in to fill the space √
- Is carried around the outside of the gears √
- As the teeth mesh again at the outlet, the fluid is force out. √ (5)

6.7 Calculation - pressure

Pressure = density x gravitational acceleration x height
= 1000 x 10 x 0.5 √ √
= 5000 Pa or 5 kPa √ (3)

6.8 Higher or lower pressure

Since pressure is directly proportional to the density, the lower the density, the lower the pressure. The density of oil is lower than that of water, therefore the pressure will be low. √√ (2)

6.9 Explain concepts

6.9.1 wear is the process in which one material rubs against another thus loosing outer skins/surfaces √√ (2)

6.9.2 overheating occurs when a material heats to unusually higher temperatures √√ (2)

6.9.3 distortion occurs when the normal shape of an object changes due to unusual pressure√√ (2)

6.9.4 friction occurs when two metal parts or surfaces rub against each other √√ (2)
[40]

TOTAL: 200