basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

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GRADE 12

MECHANICAL TECHNOLOGY

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MEMORANDUM

MARKS: 200

This memorandum consists of 17 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1 B ✓

1.2 D ✓

1.3 C ✓

1.4 A ✓

1.5 B ✓

1.6 D ✓

1.7 C ✓

1.8 B ✓

1.9 A ✓

1.10 D ✓

1.11 A ✓

1.12 C ✓

1.13 B ✓

1.14 D ✓

1.15 A ✓

1.16 C ✓

1.17 B ✓

1.18 D ✓

1.19 C ✓

1.20 A ✓ **[20]**

QUESTION 2: TOOLS AND EQUIPMENT

2.1 Computerized/computer numerical control ✓✓ (2)

2.2 **Advantages of CNC:**

- CNC machines can be used continuously 24 hours a day, 365 days a year and only need to be switched off for occasional maintenance. ✓
- CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the same. ✓
- Less skilled/trained people can operate CNCs unlike manual lathes/milling machines, etc. which need skilled engineers. ✓
- CNC machines can be updated by improving the software used to drive the machines. ✓
- Training time for CNC machine operators is reduced. ✓
- Cut production costs in the long run ✓
- Interchangeable (tool and cutters) done automatically ✓
- Multiple tool post ✓
- Tool lasts much longer ✓
- Table and cutter movement can be done in more direction at the same time ✓
- CNC machines can be programmed by advanced design software to cater for manufacture of any product ✓
- The product can be simulated and made without manufacturing the prototype ✓
- One person can supervise many CNC machines at once ✓

ANY 3 x 1 (3)

2.3 **Disadvantages of CNC:**

- CNC machines are more expensive than manually operated machines. ✓
- The CNC machine operator only needs basic training and skills, not trained enough to supervise. ✓
- If the computer software becomes faulty the operator will not be able to repair the machine ✓
- Economically it is viable for mass production ✓
- Cutting tools are very expensive ✓
- Machine is only suitable for mass production ✓
- Qualified technicians not necessary, only operators ✓
- Less workers are required to operate CNC machines compared to manually operated machines ✓

ANY 1 x 1 (1)

2.4 **Testing equipment used to test the resistance to bending, scratching, abrasion or cutting:**

Hardness Tester ✓ (Brinell or Rockwell or Vickers) ✓
File, scratch, grinding (2)

2.5 **Compression test:**

2.5.1 **High tension leads:**

The ignition system will be disabled ✓
Remove spark plug ✓
Remove spark plug/electrical shock ✓

ANY 1 x 1 (1)

2.5.2 **Fuel injectors:**

To prevent unburned fuel entering the exhaust system especially cars fitted with catalytic converters ✓
To prevent fuel to enter the tester ✓

ANY 1 x 1 (1)

2.5.3 **Throttle valve:**

To obtain the correct amount of air to enter the cylinder to obtain a correct reading ✓

ANY 1 x 1 (1)

2.5.4 **Readings:**

- The reading obtained during the compression test can be compared to the specification reading to check if the pressure is correct or not ✓
- To note the differences between the cylinders ✓ (1)

2.6 **Spring tester:**

2.6.1 Spring tester ✓ (1)

2.6.2 **Components of spring tester:**

A Compressing lever ✓
B Lower platform/Base✓
C Upper platform ✓
D Indicator/Reader/digital readout/LCD screen✓
E Scale/Pillar ✓ (5)

2.6.3 To determine properties and specifications of a tension spring ✓✓ (2)

[20]

QUESTION 3: MATERIALS

3.1 **Vehicle wheel rims:**

3.1.1 **Reasons for choosing to make vehicle wheel rims out of aluminium alloy:**

- It is light in weight ✓
- It is corrosion resistant ✓
- Has good appearance ✓
- Easy repairable ✓
- Can be manufactured in different shapes and designs ✓
- Assist in cooling the brakes ✓
- Easily cleaned ✓
- It is strong ✓

ANY 3 x 1 (3)

3.1.2 **Reasons for choosing to make vehicle rims out of steel:**

- Steel has a higher load carrying capacity ✓
- Steel has high tensile strength ✓
- It is less expensive ✓

ANY 2 x 1 (2)

3.2 **Tin Snips:**

3.2.1 High carbon steel/chrome vanadium/tungsten /high speed steel ✓
It has a high resistance to wear and shearing ✓ (2)

3.2.2 To prevent it from rusting and seizing ✓
Makes cutting easier ✓ (1)

3.3 **Reasons for creating alloys:**

- Creating a harder tougher metal ✓
- Producing a stronger metal ✓
- Increasing the resistance to corrosion and rust ✓
- Changing the colour of the metal ✓
- Increasing or decreasing electrical resistance ✓
- Improving ductility and elasticity ✓
- Improving casting properties ✓
- Strengthening the metal against wear ✓
  Lowering the cost of the metal ✓
- Lowering the melting point to below the mean of the metal components ✓
- Lightweight ✓
- Longer-lasting ✓

ANY 4 x 1 (4)

3.4 **Thermo and thermo-setting plastics:**

3.4.1 **Thermoplastics:**

It can be re-heated and remoulded ✓✓

OR

They are soft ✓✓

Thermo setting plastics:

It cannot be re-heated and remoulded ✓✓

OR

They are hard ✓✓

(4)

3.4.2 **Examples of thermoplastics**

- Acrylic (Perspex) ✓
- Polythene (Polyethylene) ✓
- Polyvinyl Chloride (PVC) ✓

ANY 1 x 1

Examples of thermo-setting plastics:

- Polyurethane ✓
- Melamine Formaldehyde ✓
- Polyesters resins ✓
- Nylon ✓
- Teflon/Tufnal ✓
- Carbon fibre ✓

ANY 1 x 1 (2)

3.5 **Uses of carbon fibre:**

It makes the equipment much tougher and stronger ✓
It makes the equipment much lighter ✓
Can be moulded into various shapes ✓
Good appearance ✓
Low coefficient of expansion ✓
Does not require lubrication ✓
Automotive engineering ✓

ANY 2 x 1 (2)

[20]

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS

4.1 **Bearing pullers:**

- Make sure that the legs of a puller are not worn out; this can cause them to slip ✓
- Make sure that the legs of the puller are well secured when pulling ✓
- Use split covers to prevent injuries ✓
- When using the puller do not work directly behind the puller. ✓
- Always focus on the puller when tightening so that other components are not damaged during the process. ✓
- Personal safety ✓
- Make certain the puller the correct one for the job ✓
- Make certain the puller is strong enough to remove the bearing ✓
- Do not use the hammer on the puller ✓
- Use the right spanner to tighten the clamps ✓
- Make certain the puller is at 90 degrees angle to the work piecel ✓

Any 5 x 1 (5)

4.2 **Lathe and drill press:**

- Make sure that the machine stands on a rigid surface ✓
- Make sure the machine is in a good working order ✓
- Make sure that all bolts that hold the machine are tight ✓
- Make sure that all the guards are in place ✓
- Make sure the area around the machine is clean and free from oil and grease ✓
- Use safety equipment for personal safety ✓
- Never work on the machine without the necessary training ✓
- The machine should run at the correct speed for the job ✓
- Do not force the drill or cutter into the work piece ✓
- Use a brush or wooden rod to remove chips from the working space ✓
- When reaching around the revolving drill be careful that your clothes do not get caught in the drill or drill chuck ✓

ANY 5 x 1 (5)

4.3 **Feed in millimetres per minute:**

$v = \pi DN$ ✓

$N = \frac{v}{\pi D}$ ✓

$= \frac{35}{\pi \text{ x } 0{,}08}$

$N = 139{,}260575 \text{ rpm}$ ✓

but,

$f = f_1 \text{ x } T \text{ x } N$ ✓

$f = 0{,}02 \text{ x } 24 \text{ x } 139{,}260575$ ✓

$f = 66{,}85 \text{ mm/min}$ ✓ (6)

- If the answer is correct without a unit it should be marked as correct.
- No method marking (carrying over of incorrect answers to the next question) is to be practiced.

4.4 4.4.1 **Indexing:**

$\text{Indexing} = \frac{40}{N} \text{ or } \frac{40}{A}$ ✓

$= \frac{40}{120}$ ✓

$= \frac{4}{12}$

$= \frac{1}{3} \times \frac{8}{8}$ ✓

$= \frac{8}{24}$ ✓

Zero full turns, 8 holes on a 24 hole circle or ✓✓

$\frac{10}{30}, \frac{13}{39}, \frac{14}{42}, \frac{17}{51}, \frac{18}{54}, \frac{19}{57}, \frac{22}{66}$ (6)

4.4.2 **Change gears:**

$\frac{Dr}{Dn} = (N - n) \times \frac{40}{N}$ ✓

$= (120 - 119) \times \frac{40}{120}$ ✓

$= \frac{1}{3}$ ✓

$= \frac{1}{3} \times \frac{24}{24}$ ✓

$\frac{\text{Driver}}{\text{Driven}} = \frac{24}{72}$ ✓✓ (6)

4.4.3 The index plate will turn in the same direction/clockwise/positive of the crank handle rotation. ✓✓ (2)

4.5 **Milling machines:**

- Vertical milling machine ✓
- Horizontal milling machine ✓
- Universal milling machine ✓
- CNC milling machines ✓

ANY 3 x 1 (3)

4.6 **Milling machine components:**

4.6.1 **Functions of a dividing head:**

- To divide the circumference of a work piece into equally spaced dimensions ✓
- Helical milling ✓
- Gear cutting ✓
- Flute cutting ✓
- keyway cutting ✓
- Keyway cutting ✓
- Indexing ✓
- For cutting operations where accurate angular divisions are required ✓

ANY 2 x1 (2)

4.6.2 **Functions of index plate:**

Is to enable one revolution of the crank to be further subdivided✓ into fractions of a revolution, especially where the division required is not a factor of 40. (2)

4.6.3 **Functions of a spindle:**

Accommodates the worm gear, chuck and change gear. ✓
Transfer the rotary motion needed for indexing to the work piece and change gears. ✓ (2)

4.7 **Joining methods:**

4.7.1 **Causes of slag inclusion:**

- Included angle is too narrow ✓
- Slag was not removed from previous weld ✓
- Too low current settings ✓
- High viscosity of molten metal
- Wrong size electrode

ANY 2 x1 (2)

ANY OTHER CORRECT ANSWER

4.7.2 **To prevent undercutting in a welded joint:**

- Do not use excessive current ✓
- Reduce the speed of weld ✓
- Use the correct size of electrode ✓
- Reduce the arc length ✓

ANY 2 x1 (2)

ANY OTHER CORRECT ANSWER

4.7.3 **To prevent incomplete penetration in a welded joint:**

- Use the correct current ✓
- Select the correct electrode ✓
- Prepare the joint according to specifications ✓

ANY 1 x1 (1)

4.7.4 **Destructive test and a non-destructive test:**

Destructive testing requires that a test piece is destroyed in the testing process. ✓

Non destructive testing does not involve the destruction of a test piece. ✓ (2)

4.7.5 **FOUR basic components of MIG/MAG machines:**

- An inert-gas cylinder ✓
- Gas-flow meter/regulator/gauge ✓
- A power source ✓
- A wire-feed controller and wire ✓
- A welding gun/nozzle ✓

ANY 4 x1 (4)
[50]

QUESTION 5: MAINTENANCE AND TURBINES

5.1 **Definitions of motor oil terms:**

5.1.1 **Pour point:**

Refers to the lowest temperature ✓ at which a liquid can flow/pour ✓ (2)

5.1.2 **Viscosity of oil:**

Refers to the resistance/thickness ✓ of oil to flow ✓ (2)

5.2 **Functions of good oil:**

- It must lubricate the rolling and sliding action ✓
- Provide cooling and control temperature ✓
- It must act as a seal ✓
- It must lubricate the moving parts to keep wear of these parts to a minimum ✓
- Reduce engine noise ✓
- Prolong engine life ✓
- It must help to absorb shocks and vibration between engine parts ✓
- Cleans the inside of engine by keeping gum deposits and dirt in suspension ✓

ANY 5 X 1 (5)

5.3 **Reasons for using cutting fluid:**

- Carry away the heat generated by machining process ✓
- Acts as a lubricant ✓
- Prevents the chips from sticking and fusing to the cutter teeth ✓
- Improves quality of the finish of the surface ✓
- To obtain a high cutting speed ✓
- It gives a cutting tool a longer lifespan ✓
- Productivity is increased because the cutting process is faster
- Soluble oil prevents corrosion

ANY 3 X 1 (3)

5.4 **Functions of Automation Transmission Fluid (ATF):**

- Transmitting power to the torque convertor. ✓
- Acting as hydraulic fluid transmitting energy to various components in the automatic transmission. ✓
- Acting as a heat transfer medium. ✓
- Acting as a lubricant for gears and bearing. ✓
- It absorbs torsion shocks and vibrations

ANY 3 X 1 (3)

5.5 **Types of motor oil:**

5.5.1 SAE 30W 40/SAE 50 or any other possible oil grade up to SAE 40 ✓✓ (2)

5.5.2 SAE 80W 90/Heavy duty oil/EP/HD ✓✓ (2)

5.5.3 ATF (Automatic transmission fluid) ✓✓ (2)

5.6 **Gas turbine:**

A gas turbine is also called a combustion turbine/jet engine ✓ (1)

5.7 **Turbocharger:**

5.7.1 **Components of the turbo-charger:**

A Turbine exhaust gas outlet ✓
B Turbine wheel/blade/fin /impeller ✓
C Turbine exhaust gas inlet ✓
D Compressor air discharge ✓
E Compressor wheel/blade/fin ✓
F Compressor air inlet ✓
G Compressor housing/casing ✓
H Turbine housing/casing ✓ (8)

5.7.2 **Operation of the turbocharger:**

- The exhaust gases from the engine is routed to the turbine wheel to enable the turbine wheel to spin at very high speed ✓
- The gases are then channeled out of the housing and wheel assembly into the normal exhaust system ✓
- As the turbine wheel spins, it turns a common shaft, which in turn spins the compressor wheel ✓
- The compressor draws air in through the compressor inlet ✓
- The compressor compresses and delivers the compressed air through the output and the induction passage then into the cylinders ✓
- This boosted pressure delivered to the cylinders increases the volumetric efficiency of the engine as well as the engine performance ✓

(6)

5.8 **Turbocharger terminology:**

5.8.1 **Lag:**

It is a delay between pushing on the accelerator pedal and feeling the turbo kick in. It is because of the time taken by the exhaust system driving the turbine to come to high pressure and for the turbine rotor to overcome its rotational inertia and reach the speed necessary to supply boost pressure. ✓✓ (2)

5.8.2 **Boost:**

Refers to the increase in manifold pressure that is generated by the turbocharger in the intake path or intake manifold that exceeds normal atmospheric pressure ✓✓ (2)

[40]

QUESTION 6: FORCES AND SYSTEMS AND CONTROL

6.1 **Hydraulics:**

6.1.1 **Fluid pressure:**

$$A_B = \frac{\pi D^2}{4}$$ ✓

$$A_B = \frac{\pi(0{,}232)^2}{4}$$ ✓

$$A_B = 42{,}27327 \times 10^{-3}\,m^2$$ ✓

$$P = \frac{F_B}{A_B}$$ ✓

$$P = \frac{25 \times 10^3}{42{,}27 \times 10^{-3}}$$ ✓

$$= 591\,390{,}25\ Pa$$

$$= 0{,}59\ MPa$$ ✓ (6)

- If the answer is correct without a unit it should be marked as correct.
- No method marking (carrying over of incorrect answers to the next question) is to be practiced.

6.1.2 **Force F on piston A:**

$$A_A = \frac{\pi D^2}{4}$$ ✓

$$A_A = \frac{\pi \times (0{,}068)^2}{4}$$ ✓

$$A_A = 3{,}631\,683 \times 10^{-3}\,m^2$$

$$P_A = P_B$$ ✓

$$P_A = \frac{F_A}{A_A}$$

$$F_A = P_A \times A_A$$ ✓

$$F_A = (0{,}59 \times 10^6)(3{,}63 \times 10^{-3})$$

$$F_A = 2\ 147{,}74\ N$$

$$F_A = 2{,}15\ kN$$ ✓✓

OR

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$ ✓

$$F_1 = \frac{F_2 \times A_1}{A_2}$$ ✓

$$= \frac{25 \times 10^3 \times 3{,}63 \times 10^{-3}}{42{,}27 \times 10^{-3}}$$ ✓ ✓

$$= 2\ 147{,}7\ N$$

$$= 2{,}15\,kN$$ ✓✓

(6)

6.1.3 **Distance X:**

$$V_B = V_A \quad ✓$$

$$A_B \times X = A_A \times L_A \quad ✓$$

$$X = \frac{A_A \times L_A}{A_B} \quad ✓$$

$$X = \frac{(3{,}63 \times 10^{-3})(0{,}25)}{42{,}27 \times 10^{-3}} \quad ✓$$

$$X = 21{,}48 \text{ mm/stroke}$$

$$\text{for 10 strokes} = 21{,}48 \times 10 \quad ✓$$

$$= 214{,}8 \text{ mm}$$

$$\text{Movement of piston B} = 214{,}8 \text{ mm} \quad ✓$$

(6)

OR

$$\text{Work done at }_B = \text{Work done at }_A$$

$$F_B \times d_B = F_A \times d_A \quad ✓$$

$$d_B = \frac{F_A \times d_A}{F_B} \quad ✓$$

$$d_B = \frac{2147{,}7 \times 0{,}25}{25000} \quad ✓$$

$$d_B = 21{,}48 \text{ mm/stroke} \quad ✓$$

$$\text{for 10 strokes} = 21{,}48 \times 10$$

$$= 214{,}8 \text{ mm} \quad ✓$$

$$\text{Movement of piston B} = 214{,}8 \text{ mm} \quad ✓$$

6.2 Stress and strain:

6.2.1 Diameter:

$$\sigma = \frac{F}{A}$$
$$A = \frac{F}{\sigma} \quad ✓$$
$$A = \frac{45\times10^{3}}{18\times10^{6}} \quad ✓$$
$$A = 2{,}5\times10^{-3}\,\text{m}^{2} \quad ✓$$

$$A = \frac{\pi D^{2}}{4} \quad ✓$$
$$D = \sqrt{\frac{4A}{\pi}} \quad ✓$$
$$D = \sqrt{\frac{4\left(2{,}5\times10^{-3}\right)}{\pi}} \quad ✓$$
$$D = 56{,}42\times10^{-3}\ \text{m}$$
$$D = 56{,}42\ \text{mm} \quad ✓$$

(8)

6.2.2 Strain:

$$E = \frac{\sigma}{\varepsilon} \quad ✓$$
$$\varepsilon = \frac{\sigma}{E} \quad ✓$$
$$\varepsilon = \frac{18\times10^{6}}{90\times10^{9}} \quad ✓$$
$$\varepsilon = 0{,}2\times10^{-3} \quad ✓$$

(4)

6.2.3 Change in length:

$$\varepsilon = \frac{\Delta\ell}{o\ell} \quad ✓$$
$$\Delta\ell = \varepsilon\times o\ell \quad ✓$$
$$\Delta\ell = \left(0{,}2\times10^{-3}\right)\times185$$
$$= 0{,}037\,\text{mm} \quad ✓$$

(3)

6.3 **Belt drives:**

6.3.1 **Diameter of the driven pulley:**

$$D_{DN} \times N_{DN} = D_{DR} \times N_{DR} \quad ✓$$

$$D_{DN} = \frac{D_{DR} \times N_{DR}}{N_{DN}} \quad ✓$$

$$= \frac{210 \times 2700}{1000} \quad ✓$$

$$= 567\, mm \quad ✓$$

(4)

6.3.2 **Power transmitted:**

$$P = \frac{(T_1 - T_2)\pi DN}{60} \quad ✓$$

$$= \frac{400 \times \pi \times 0{,}21 \times 2700}{60} \quad ✓✓$$

$$= 11\,875{,}22 \text{ Watt}$$

$$= 11{,}88 \text{ kW} \quad ✓$$

$$T_1 - T_2 = T_e$$

(4)

6.4 **Clutches:**

6.4.1 **The total applied force on the pressure plate needed:**

$$T = \mu WnR \quad ✓$$

$$W = \frac{T}{\mu nR} \quad ✓$$

$$= \frac{336}{0{,}3 \times 2 \times 0{,}14} \quad ✓✓$$

$$= 4000\, N$$

$$= 4\, kN \quad ✓$$

(5)

6.4.2 **Power transmitted at 2 800 rpm in kW:**

$$P = \frac{2\pi NT}{60} \quad ✓$$

$$P = \frac{2 \times \pi \times 2800 \times 336}{60} \quad ✓$$

$$P = 98\,520{,}35 \text{ Watt}$$

$$P = 98{,}52 \text{ kW} \quad ✓✓$$

(4)
50

TOTAL: 200