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 16 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1 C ✓

1.2 D ✓

1.3 A ✓

1.4 C ✓

1.5 C ✓

1.6 B ✓

1.7 A ✓

1.8 A ✓

1.9 C ✓

1.10 D ✓

1.11 B ✓

1.12 A ✓

1.13 C ✓

1.14 B ✓

1.15 D ✓

1.16 A ✓

1.17 C ✓

1.18 B ✓

1.19 D ✓

1.20 A ✓

[20]

QUESTION 2: TOOLS AND EQUIPMENT

2.1 **Procedure for compression testing:**

- Run the engine until it reaches normal operating temperature. ✓
- Remove the high-tension leads and take out the spark plugs to disable the ignition system. ✓
- Disconnect the fuel supply to the cylinders. ✓
- Screw the gauge into cylinder one's spark plug hole and rest it where you can see the dial while you crank the engine. ✓
- Fully open the throttle. ✓
- Crank the engine until the dial stops rising. (±10 revolutions) ✓
- Write down the final reading and reset the gauge to '0'. ✓
- Repeat the procedure on all the cylinders and compare the reading with the manufacturer manual. ✓ (8)

2.2 **Testing of materials:**

2.2.1 Bending test: It is used to determine the ductility or toughness of a material ✓✓ (2)

2.2.2 Tensile test: It is used to determine the tensile strength of a material ✓✓ (2)

2.3 **Multimeter:**

To measure:

- DC current ✓
- DC voltage ✓
- AC voltage ✓
- Resistance ✓
- Temperature ✓
- Transistor ✓
- Diode ✓
- Battery ✓

ANY 4 x 1 (4)

2.4 **Brinell hardness tester:**

A - Applied force ✓
B - Ball ✓
C - Work piece ✓
D - Indentation ✓ (4)

[20]

QUESTION 3: MATERIALS

3.1 **Hammer head:**

3.1.1 **Type of material:**

Medium carbon steel ✓ (1)

3.1.2 **Properties:**

- stronger than low carbon steel ✓
- not as ductile as low carbon steel ✓
- Less brittle than high carbon steel ✓

ANY 2 x 1 (2)

3.1.3 **Heat Treatment:**

With heat treatment it becomes tougher and harder ✓✓ (2)

3.2 **Greenhouse frame:**

3.2.1 **Properties:**

- corrosion resistant ✓
- strong ✓
- good appearance ✓ (3)

3.2.2 **Advantages over a solid bar:**

- light in weight ✓
- cheaper ✓ (2)

3.2.3 It will rust easily and is not as strong ✓✓ (2)

3.3 **Electrical three pin plug:**

3.3.1 **Material for Pin:**

Copper/Brass. ✓

Reasons:

- good conductor of electricity ✓
- corrosion resistant ✓ (3)

3.3.2 **Casing:**

Nylon/PVC✓

ANY 1X1

Reasons:

- good insulator ✓
- cheap to manufacture ✓
- good impact resistance ✓
- resistance to natural elements such as sun, cold and heat ✓

ANY 2x1 (3)

3.4 **Properties of carbon fibre:**

- light in weight ✓
- resistant to corrosion ✓
- strong ✓
- low density ✓

ANY 2 x1 (2)

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QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS

4.1 **Milling machine:**

- select the correct tool for the job ✓
- make sure that all guards are in place ✓
- make sure that there is no oil and grease on the floor around the machine ✓
- tools must never be left on moving parts ✓
- work pieces and holding devices must be firmly clamped ✓
- use a wire hook or brush to remove cuttings ✓
- never adjust the cutting tool while the machine is running ✓
- do not lean on the machine ✓

ANY 4 x1 (4)

4.2 **Spring compressors:**

- Do not use wire or rope to compress the coil spring, use spring compressors ✓
- Ensure that the equipment is absolutely safe ✓
- Make sure that the compressors are well in place before compressing the coil spring by turning the bolts ✓
- Compressing and releasing the coil springs must take place slowly and evenly ✓

ANY 2 x1 (2)

4.3 **MIGS/MAGS welding:**

- Always wear the correct personal protective clothes ✓
- Make sure that the welding area is well ventilated ✓
- Ensure there are no fire hazards in the workshop and that adequate fire protection is in place ✓
- Ascertain that equipment is safe before being used ✓

ANY 3 x1 (3)

4.4 **Indexing:**

Indexing for 17 teeth:

$$\text{Indexing} = \frac{40}{n} \quad \checkmark$$

$$= \frac{40}{17} \quad \checkmark$$

$$= 2\frac{6}{17} \times \frac{2}{2} \quad \checkmark$$

$$= 2\frac{12}{34} \quad \checkmark$$

2 full turns 12 holes on a 34 hole circle ✓

or 2 full turns 18 holes on a 51 hole circle

(5)

4.5 Indexing:

4.5.1 Indexing required:

$$\text{Indexing} = \frac{40}{N} \quad \checkmark$$

$$= \frac{40}{90} \quad \checkmark$$

$$= \frac{4}{9} \text{x} \frac{6}{6} \quad \checkmark$$

$$= \frac{24}{54} \quad \checkmark$$

Indexing $= 0$ full turns and 24 holes on a 54 hole circle ✓ (5)

4.5.2 Change gears required:

$$\text{Change gears} = (N - n) \times \frac{40}{N} \quad \checkmark$$

$$= (90 - 91) \times \frac{40}{90} \quad \checkmark \checkmark$$

$$= -\frac{4}{9} \quad \checkmark$$

$$= \frac{4}{9} \times \frac{8}{8} = \frac{32}{72} \quad \checkmark$$

$$\frac{\text{Driver}}{\text{Driven}} = \frac{32}{72} \quad \checkmark$$ (6)

4.6 MIGS/MAGS Welding process:

A - Gas shroud ✓
B - Nozzle ✓
C - Wire feed ✓
D - Arc ✓
E - Inert shielded gas ✓
F - Parent metal ✓
G - Molten weld pool ✓ (7)

4.7 **Uses of cutters:**

4.7.1 T-slot milling cutters are designed for cutting T-slots in machine tables and similar applications. (1)

4.7.2 End mill cutters are used for machining slots, keyways, pockets, facing narrow faces and cutting profiles (1)

4.7.3 Slitting saw cutters are used for parting off and slitting thin sections and the cutting of deep and narrow slots (1)

4.7.4 Form ('Profile') cutters are used for producing hollows, corner-rounded edges, gears, formed tooth and threads (1)

4.8 **Welded Joints:**

4.8.1 **Porosity causes:**

- Surface contamination ✓
- Rusted MIG wire ✓
- Atmospheric contamination ✓
- Dirty or wet electrodes ✓

ANY 2x1 (2)

Porosity preventions:

- Clean the surface ✓
- Use the correct electrode ✓
- Check for impurities in base metal ✓

ANY 1x1 (1)

4.8.2 **Slag inclusion preventions:**

- By chipping off the slag from the previous weld runs ✓
- Brushing the weld bead with a wire brush before further welding ✓
- Use the correct current setting ✓
- Increase the included angle ✓

ANY 2x1 (2)

4.8.3 **Distortion:**

The twisting of a metal out of shape due to uncontrolled expansion and contraction forces due to weld heat ✓✓ (2)

4.8.4 **Arc welding:**

- Rate of the electrode burning and the progress of the weld ✓
- Amount of penetration and fusion ✓
- The way the weld metal is flowing ✓
- The sound of the arc, indicating the correct current and voltage for the particular weld ✓

ANY 3x1 (3)

4.8.5 **MIG/MAGS:**

- Can weld in any position ✓
- Higher deposition rate ✓
- Less operator skill required ✓
- Long welds can be made without stops and starts ✓
- Minimal post weld cleaning is required ✓

ANY 4x1 (4)

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QUESTION 5: MAINTENANCE AND TURBINES

5.1 **Reasons for bearing failure:**

- Insufficient lubrication ✓
- Excessive lubrication ✓
- Grease flowing ✓
- Foaming oil ✓
- 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)

5.2 **Importance of oil seal:**

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

5.3 **Oil terms:**

- Corrosion resistance is the ability of oil to displace water from the metal allowing the oil to coat the surfaces ✓
- Rust resistance also has the alkaline reaction to neutralize combustion acid thus preventing corrosion ✓ (2)

5.4 **Cutting fluids:**

- 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 keep the work piece and the cutting tool cool ✓
- To obtain a high cutting speed ✓
- It gives a cutting tool a longer lifespan ✓

ANY 4 X 1 (4)

5.5 **Gearbox oil change:**

- Draining must be done at normal working temperature. ✓
- Locate the filler plug on the side of the gearbox casing and wipe the plug and area around it clean. Place tray under the gearbox. ✓
- Remove the filler plug. ✓
- Remove the drain plug using a well-fitting spanner in the base of the gearbox. ✓
- Allow oil to drain out of the gearbox into the drain pan. ✓
- Clean the drain plug and make sure to fit a new sealing washer. ✓
- Replace the drain plug and make sure it is tight. ✓
- Refill the gearbox with the recommended oil to the base of the filler plug and allow excess oil to trickle out and refit the filler plug. ✓ (8)

5.6 **Blower:**

5.6.1 Vane type blower ✓ (1)

5.6.2 **Labels of a blower:**

A - Vane ✓
B - Inlet ✓
C - Rotor ✓
D - Housing ✓
E - Outlet ✓ (5)

5.6.3 **Operation of a blower:**

- Engine drives the rotor by means of a belt drive ✓
- Thus creating a vacuum when air is taken in through the inlet port ✓
- The 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 ✓
- This air is forced through the inlet manifold into the cylinders ✓ (5)

5.7 **Difference between turbo and supercharger:**

- Turbocharger is driven by the exhaust gases of the engine ✓
- Supercharger is mechanical driven by using the engine power ✓ (2)

5.8 **Advantage of supercharger:**

- Increases the output power of the engine ✓
- A smaller engine fitted with a centrifugal blower delivers the same power as a larger engine ✓
- It eliminates lack of oxygen above sea level ✓
- Increases the volumetric efficiency of the engine ✓
- With the aid of the intercooler both the power and the torque output of the engine are increased ✓

ANY 3 X 1 (3)

5.9 **Advantages of steam turbines:**

- It is compact ✓
- No lubrication is required ✓
- Steam turbine speeds can be more accurately regulated ✓
- A variety of fuels can be used to obtain steam ✓
- Steam turbines are more economical ✓
- Higher speeds can be obtained as compared to internal combustion engine ✓
- Convert heat energy into mechanical energy ✓

ANY 3 X 1 (3)

5.10 **Disadvantage of steam turbine:**

- Needs a large area for fuel storage ✓
- Cooling towers are used to regulate steam to reduce the usage of water ✓

ANY 1 X 1 (1)

[40]

QUESTION 6: FORCES AND SYSTEMS AND CONTROL

6.1 Stress and Strain:

6.1.1 Compressive stress ✓ (1)

6.1.2 **Stress:**

$$\sigma = \frac{F}{A} \quad ✓$$

$$= \frac{3\times10^{3}}{10{,}08\times10^{-3}} \quad ✓$$

$$= 0{,}298\times10^{6}\ \text{Pa} \quad ✓$$

$$= 0{,}298\ \text{MPa} \quad ✓$$ (4)

6.1.3 **Strain:**

$$\varepsilon = \frac{\Delta L}{L} \quad ✓$$

$$= \frac{0{,}5\times10^{-3}}{3{,}5} \quad ✓$$

$$= 0{,}143\times10^{-3} \quad ✓$$ (3)

6.1.4 **Elasticity modulus:**

$$E = \frac{\sigma}{\varepsilon} \quad ✓$$

$$= \frac{0{,}298\times10^{6}}{0{,}143\times10^{-3}} \quad ✓$$

$$= 2{,}08\times10^{9}$$

$$= 2{,}08\ \text{GPa} \quad ✓$$ (3)

6.2 Gear drives:

6.2.1 **Number of teeth on idler gear:**

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

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

$$= \frac{700\times56}{980} \quad ✓$$

$$= 40\ \text{teeth} \quad ✓$$ (4)

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

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

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

$$= \frac{700 \times 56}{64} \quad \checkmark$$

$$= 612.5 \text{ rpm} \quad \checkmark$$

(4)

6.2.3 Anti-clockwise ✓✓ (2)

6.3 **Belt drives:**

6.3.1 **Diameter of the pulley that needs to be fitted onto the machine:**

$$N_{dn} \times D_{dn} = N_{dr} \times D_{dr} \quad \checkmark$$

$$D_{dn} = \frac{N_{dr} \times D_{dr}}{N_{dn}} \quad \checkmark$$

$$= \frac{9,4 \times 640}{15} \quad \checkmark$$

$$= 401,07 \text{ mm}$$

$$= 400 \text{ mm} \quad \checkmark$$

(4)

6.3.2 **Power transmitted:**

$$\frac{T_1}{T_2} = 2,5 \quad \checkmark$$

$$T_2 = \frac{T_1}{2,5} \quad \checkmark$$

$$T_2 = \frac{320}{2,5}$$

$$= 128 \text{N} \quad \checkmark$$

but

$$\text{Power} = (T_1 - T_2) \times \pi \times DN \quad \checkmark$$

$$= (320 - 128) \times \pi \times 0,64 \times 9,4$$

$$= 192 \times \pi \times 0,64 \times 9,4 \quad \checkmark$$

$$= 3628,76 \text{ Watt}$$

$$= 3,628 \text{kW} \quad \checkmark$$

(6)

6.4 Hydraulics:

6.4.1 Pressure:

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

$$= \frac{\pi(0,04)^2}{4} \quad \checkmark$$

$$A_A = 1,257 \times 10^{-3}\,m^2 \quad \checkmark$$

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

$$= \frac{0,9 \times 10^3}{1,257 \times 10^{-3}} \quad \checkmark$$

$$= 715990,45\,Pa$$

$$= 715,990\,kPa \quad \checkmark$$

(5)

6.4.2 Number of strokes:

The volume of the system stays the same

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

$$= \frac{\pi(0,240)^2}{4}$$

$$= 45,24 \times 10^{-3} m^2 \quad \checkmark$$

Volume displayed by A = Volume displayed by B

$$V_A = V_B \quad \checkmark$$

$$A_A \times L_A = A_B \times L_B$$

$$L_A = \frac{A_B \times L_B}{A_A} \quad \checkmark$$

$$= \frac{(45,24 \times 10^{-3})(35 \times 10^{-3})}{1,257 \times 10^{-3}} \quad \checkmark$$

$$= 1,26\,m \quad \checkmark$$

$$\text{Number of strokes by piston A} = \frac{L_A}{\text{One stroke length}} \quad \checkmark$$

$$= \frac{1,26}{0,126} \quad \checkmark$$

$$= 10\,\text{strokes} \quad \checkmark$$

(9)

6.5 **Clutch:**

Effective diameter:

$$T = \mu W n R \quad \checkmark$$

$$R = \frac{T}{\mu W n} \quad \checkmark$$

$$R = \frac{240}{0,6 \times 3,4 \times 10^3 \times 2} \quad \checkmark$$

$$R = 0,059\,m$$

$$\text{Effective diameter} = R \times 2 \quad \checkmark$$

$$D = 0,059 \times 2$$

$$D = 0,118\,m \quad \checkmark$$

$$= 118\,mm$$

(5)
[50]

GRAND TOTAL: 200