basic education

Department:
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GRADE 12

MECHANICAL TECHNOLOGY

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MEMORANDUM

MARKS: 200

This memorandum consists of 15 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

MECHANICAL TECHNOLOGY ANSWER SHEET

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

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QUESTION 2: TOOLS AND EQUIPMENT

2.1 CYLINDER LEAKAGE TEST:

Listen at the carburettor for a hissing noise ✓ inlet valve is leaking ✓
Listen at the exhaust pipe for a hissing noise ✓ exhaust valve is leaking ✓
Listen for a hissing noise in the dipstick hole ✓ piston ring is worn ✓
Remove the filler cap on the tappet cover and listen for a hissing noise ✓ rings are worn ✓
If you see bubbles in the radiator water ✓ the cylinder-head gasket is blown or cracked cylinder head or engine block ✓ **Any 1 x 2** (2)

2.2 GAS ANALYSER:

Rich mixture setting ✓
Incorrect idle speed ✓
Clogged air filter ✓
Faulty choke creating a rich mixture (jammed in the closed position) ✓
Any 2 x 1 (2)

2.3 TESTS ON METALS:

2.3.1 A tensile test is to measure the yield stress, ultimate tensile stress and percentage elongation of a piece of metal. ✓✓ (2)

2.3.2 The purpose of the beam bending test is to investigate the deflection of beams. ✓✓ (2)

2.4 HARDNESS TESTERS:

Brinnel hardness tester ✓ (1)
Rockwell hardness tester ✓ (1)

2.5 MULTIMETER:

DC current measurement✓
DC voltage measurement✓
AC voltage measurement✓
Resistance measurement✓
Temperature measurement✓
Transistor testing✓
Diode measurement✓
Continuity measurement✓
Battery measurement✓ **Any 3 x 1** (3)

2.6 MAGS WELDING NOZZLE:

A – Electrode ✓ (1)
B – Solidified slag ✓ (1)
C – Shielding gas ✓ (1)
D – Arc ✓ (1)
E – Weld pool ✓ (1)
F – Base metal ✓ (1)
G – Weld metal ✓ (1)
[20]

QUESTION 3: MATERIALS

3.1 **FERROUS ALLOYS:**

Carbon ✓ and iron ✓ (2)

3.2 **TORSIONAL STRESS:**

3.2.1 Material B has the highest torsional strength ✓ (1)

3.2.2 Reason: Material B has twisted the least which means that it has more ability to withstand twisting forces, or torsion. ✓✓ (2)

3.3 **NON-FERROUS ALLOYS:**

3.3.1 A non-ferrous alloy is a metal that has a combination of two or more non-ferrous metals, which are melted together to form one alloy ✓✓ (2)

3.3.2 **Examples of non-ferrous alloys:**
Brass /Yellow copper ✓
Bronze ✓
Phosphor bronze ✓
White metal ✓
Duralumin ✓
Solder ✓
Silver solder ✓
Pewter ✓ **Any 3 x 1** (3)

3.4 **MATERIALS FOR TAP:**

3.4.1 Brass ✓✓ (2)

3.4.2 Brass or bronze ✓ (1)

3.4.3 Brass/Plastic/Perspex/Nylon/Pewter ✓ (1)

3.4.4 Corrosion resistant ✓
Ductile ✓
Malleable ✓
Easily machineable ✓
Can be easily moulded into shapes ✓
Resistant to wear ✓ **Any 4 x 1** (4)

3.4.5 To provide a water tight seal when closed. ✓✓ (2)
[20]

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS

4.1 **MILLING-MACHINE PARTS:**

A Overarm ✓
B Base ✓
C Knee ✓
D Hand wheel ✓
E Machine table ✓
F Arbor support ✓ (6)

4.2 By adding another helical cutter in the opposite direction. ✓✓ (2)

4.3 **CUTTING FEED:**

$$V = \pi DN$$

$$N = \frac{V}{\pi D} \quad ✓$$

$$N = \frac{120}{\pi \times 0{,}14} \quad ✓$$

$$N = 272{,}8370453 \text{ r/min} \quad ✓$$

$$f = f_1 \times T \times N \quad ✓$$

$$f = 0{,}1 \times 46 \times 272{,}84 \quad ✓$$

$$f = 1\,255{,}06 \text{ mm/min} \quad ✓$$

(6)

4.4 **INDEXING METHODS:**

4.4.1 Direct/Rapid indexing ✓ (1)

4.4.2 Differential indexing ✓ (1)

4.4.3 Simple indexing ✓ (1)

4.5 **MILLING CUTTERS:**

4.5.1 Cylindrical/helical(slab) plain milling cutter ✓ (1)

4.5.2 Single-angle milling cutter ✓ (1)

4.5.3 Concave-milling cutter ✓ (1)

4.5.4 Dovetail cutter ✓ (1)

4.6 **GEARS:**

4.6.1 **Module of small gear:**

$$\text{module}(m) = \frac{PCD}{T}$$

$$m = \frac{87,75}{39} \quad ✓$$

$$= 2,25\,\text{mm} \quad ✓$$

(2)

4.6.2 **Module of large gear:**

$$\text{module}(m) = \frac{PCD}{T}$$

$$= \frac{126}{56} \quad ✓$$

$$= 2,25\ \text{mm} \quad ✓$$

(2)

4.6.3 **Outside diameter of large gear:**

$$OD = PCD + 2m \quad ✓$$

$$OD = 126 + 2(2,25) \quad ✓$$

$$= 130,50\ \text{mm} \quad ✓$$

(3)

4.6.4 **Dedendum of large gear:**

$$D = 1,157\,\text{m} \qquad\qquad D = 1,25\,\text{m} \quad ✓$$

$$= 2,60\ \text{mm} \qquad OR \qquad = 2,81\ \text{mm} \quad ✓$$

(2)

4.6.5 **Clearance of large gear:**

$$C = 0,157\,\text{m} \qquad\qquad C = 0,25\,\text{m} \quad ✓$$

$$= 0,35\ \text{mm} \qquad OR \qquad = 0,56\ \text{mm} \quad ✓$$

(2)

4.6.6 **Indexing on the large gear:**

$$Indexing = \frac{40}{n}$$

$$= \frac{40}{56} \quad ✓$$

$$= \frac{20}{28}\ or\ \frac{30}{42}\ or\ \frac{35}{49} \quad ✓$$

20 *holes on the* 28 *hole circle or* ✓

30 *holes on the* 42 *hole circle or*

35 *holes on the* 49 *hole circle*

(3)

4.7 **NON-DESTRUCTIVE TESTS:**
Dye-penetrant test ✓
X-ray test ✓
Ultrasonic test ✓ (3)

4.8 **WELD DEFECTS:**

4.8.1 **Insufficient penetration:**
Speed too fast ✓
Joint designed faulty ✓
Electrode too large ✓
Current too low ✓ **Any 2 x 1** (2)

4.8.2 **Porosity:**
Atmospheric contamination. ✓
Surface contamination. ✓
Dirty or wet electrodes. ✓
Rusted MIG wire. ✓ **Any 2 x 1** (2)

4.8.3 **Welding craters:**
Current too high ✓
Improper welding technique ✓
Electrode too small ✓ **Any 2 x 1** (2)

4.9 **BRINELL HARDNESS TESTER:**
Care to be taken that the test load is not applied when the anvil is within the travel range of the ram and Brinell ball, unless the test piece is placed on anvil. ✓
Use the specified load when testing. ✓
The load must not cause any marking on the reverse side of the test piece. ✓
Any 2 x 1 (2)

4.10 **BEARING AND GEAR PULLERS:**
Make sure that the legs of the puller are not worn or bended✓
Make sure that the legs are well secured when pulling. ✓
Use split covers to prevent injuries. ✓
When using a puller, do not work directly behind the puller; if it slips it can cause injuries. ✓
Always keep an eye on the puller when tightening, so that other components are not damaged during the process. ✓ **Any 4 x 1** (4)
[50]

QUESTION 5: MAINTENANCE AND TURBINES

5.1 **FITTING A NEW OIL FILTER:**
Drain the oil at operating temperature ✓
Use a filter strap spanner and remove old filter. ✓
Clean the filter area. ✓
Put a thin smear of clean engine oil on the seal of the filter. ✓
Tighten filter by hand. ✓ (5)

5.2 **REASONS FOR OIL CHANGE:**
Formation of gums, acids and lacquer due to fuel combustion. ✓
Loses its viscosity after a while due to heat. ✓
Metal particles due to metal to metal friction are absorbed in the oil. ✓ (3)

5.3 **AUTOMATIC TRANSMISSION FLUID:**
It is dyed red (colour) ✓
Oil is thin (viscosity) ✓ (2)

5.4 **BEARINGS:**

5.4.1 **Three types of loads that a bearing can be subjected to:**
Radial load. ✓
Thrust load. ✓
Combined radial and thrust load. ✓ (3)

5.4.2 **Causes of friction bearing overheating:**
Poor lubrication. ✓
Friction is increased due to dirty oil. ✓
Incorrect grade of oil. ✓
Misalignment of bearing and shaft causing undue strain. ✓
Shaft is out off round (oval). ✓
Bearing not torque according to specification. ✓
Load on bearing excessive. ✓
Uneven bearing surfaces. ✓
Poor assembly of bearing shells, not seating properly. ✓ **Any 3 x 1** (3)

5.4.3 **Reasons for grease lubrication of a wheel bearing:**
Reduces noise ✓
Reduces friction ✓
Prevents rust ✓
Prevents overheating ✓ (4)

5.5 **TURBOCHARGERS:**

5.5.1
A Carburettor ✓
B Turbine ✓
C Compressed air ✓
D Air inlet ✓
E Turbo charger housing ✓
F Exhaust gases ✓ (6)

5.5.2 **Operation of turbocharger:**

- The exhaust gases from the engine move through the turbine at a very high speed to drive the turbine. ✓
- The gases go through the turbo-assembly into the normal exhaust system. ✓
- As the turbine wheel spins, it turns a common shaft, which turns the impeller at a high speed. ✓
- The impeller and its housing compress the air. ✓
- The compressed air is delivered through the turbo-outlet to engine inlet ✓
- The compressed air is delivered to the engine cylinders. ✓ (6)

5.5.3 **Oil cooler:**
To cool and lubricate the turbo-charger bearings. ✓✓ (2)

5.6 **ADVANTAGES OF GAS TURBINE AS USED IN A JET ENGINE:**
High power output from a given weight of engine. ✓
The high torque output simplifies the transmission system. ✓
Smooth running with less vibration due to absence of reciprocating parts.✓
No rubbing parts such as piston so that internal friction and wear are almost eliminated. ✓
Easy starting. ✓
Can use wide range of fuels. ✓
Low lubricating oil consumption. ✓
No water cooling system needed. ✓
Non-poisonous exhaust gases giving very little trouble with pollution. ✓
Requires little routine maintenance. ✓ **Any 4 x 1** (4)

5.7 **SUPERCHARGERS:**
Gear driven✓
Belt driven✓ (2)
[40]

QUESTION 6: FORCES, SYSTEMS AND CONTROL

6.1 HYDRAULICS:

6.1.1 Force on piston A:

$$A_A = \frac{\pi D^2}{4} \quad ✓$$

$$= \frac{\pi(0{,}028)^2}{4}$$

$$= 0{,}0006151752 \text{ m}^2$$

$$= 6{,}15752 \times 10^{-4} \text{ m}^2 \quad ✓$$

$$P = \frac{F_A}{A_A} \quad ✓$$

$$F_A = P \times A_A \quad ✓$$

$$= (0{,}4 \times 10^6) \times (0{,}0006151752) \quad ✓$$

$$= 246{,}30 \text{ N}$$

(5)

6.1.2 Distance 'X':

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

$$= \frac{\pi(0{,}148)^2}{4} \quad ✓$$

$$= 0{,}017203361 \text{ m}^2$$

$$= 1{,}7203361 \times 10^{-2} \text{ m}^2 \quad ✓$$

$$V_A = V_B \quad ✓$$

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

$$(6{,}15752 \times 10^{-4}) \times (10 \times 0{,}08) = (1{,}7203361 \times 10^{-2}) \times X \quad ✓$$

$$X = \frac{(6{,}15752 \times 10^{-4}) \times (10 \times 0{,}08)}{(1{,}7203361 \times 10^{-2})} \quad ✓$$

$$= 0{,}28634032 \text{ m}$$

$$= 28{,}63 \text{ mm} \quad ✓$$

(7)

6.2 STRESS AND STRAIN:

6.2.1 Diameter of bar:

$$\sigma = \frac{F}{A} \quad ✓$$

$$= \frac{12 \times 10^3}{24{,}5 \times 10^6} \quad ✓$$

$$= 0{,}489795 \times 10^{-3}\ \text{m}^2$$

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

$$D = \sqrt{\frac{4A}{\pi}} \quad ✓$$

$$= \sqrt{\frac{4 \times 0{,}489795 \times 10^{-3}}{\pi}} \quad ✓ \quad ✓$$

$$= 0{,}024972535\ \text{m}$$

$$= 24{,}97\ \text{mm} \quad ✓$$

(6)

6.2.2 Change in length:

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

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

$$= \frac{24{,}5 \times 10^6}{90 \times 10^9} \quad ✓$$

$$= 0{,}000272222 \quad ✓$$

$$= 0{,}272222 \times 10^{-3}$$

$$\varepsilon = \frac{\Delta l}{ol}$$

$$\Delta l = \varepsilon \times ol \quad ✓$$

$$= 24{,}5 \times 10^6 \times (250) \times 10^{-3} \quad ✓$$

$$= 6{,}8 \times 10^{-5}\ \text{m}$$

$$= 0{,}07\ \text{mm} \quad ✓$$

(6)

6.3 BELT DRIVE:

6.3.1 Rotation frequency of the driven pulley:

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

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

$= \dfrac{118 \times 1\,440}{230}$

$= 738{,}78$ r/min ✓

(3)

6.3.2 Belt speed:

$v = \dfrac{\pi DN}{60}$ ✓

$= \dfrac{\pi (0{,}118)(1440)}{60}$ ✓

$= 8{,}90\ \text{ms}^{-1}$ ✓

(3)

6.3.3 Power transmitted:

$2{,}5 = \dfrac{T_1}{T_2}$ ✓

$T_2 = \dfrac{T_1}{2{,}5}$ ✓

$= \dfrac{300}{2{,}5}$ ✓

$= 120$ N

$P = (T_1 - T_2)v$

$= (300 - 120)8{,}9$ ✓

$= 1\,602$ watts

or ✓

$= 1{,}60$ kW

(5)

6.4 DIFFERENTIAL WHEEL AND AXLE:

6.4.1 Effort applied:

$$MA = \frac{W}{F} \quad ✓$$

$$F = \frac{W}{MA}$$

$$= \frac{1,6}{4} \quad ✓$$

$$= 400\,\text{N} \; or \; 0,4\text{ kN} \quad ✓$$

(3)

6.4.2 Velocity ratio:

$$VR = \frac{2D}{d_1 - d_2} \quad ✓$$

$$= \frac{2(280)}{(200-120)} \quad ✓$$

$$= \frac{560}{80}$$

$$= 7:1 \quad ✓$$

(3)

6.4.3 Mechanical efficiency:

$$\text{Mechanical efficiency} = \frac{MA}{VR} \times \frac{100}{1} \quad ✓$$

$$= \frac{4}{7} \times \frac{100}{1} \quad ✓✓$$

$$= 57,14\%$$

(3)

6.5 FRICTION CLUTCH:

6.5.1 The maximum torque transmitted:

$$T = \mu WnR \quad ✓$$

$$= 0,45 \times 3500 \times 2 \times \frac{0,18}{2} \quad ✓$$

$$= 0,45 \times 3500 \times 2 \times 0,09$$

$$= 283,5\text{ Nm} \quad ✓$$

(3)

6.5.2 **Power transmitted at 4 500 r/min in kW:**

$$P = \frac{2\pi NT}{60}$$ ✓

$$= \frac{2\pi \times 4500 \times 283{,}5}{60}$$ ✓

$$= 133{,}6 \text{ kW}$$ ✓

(3)
[50]

TOTAL: 200