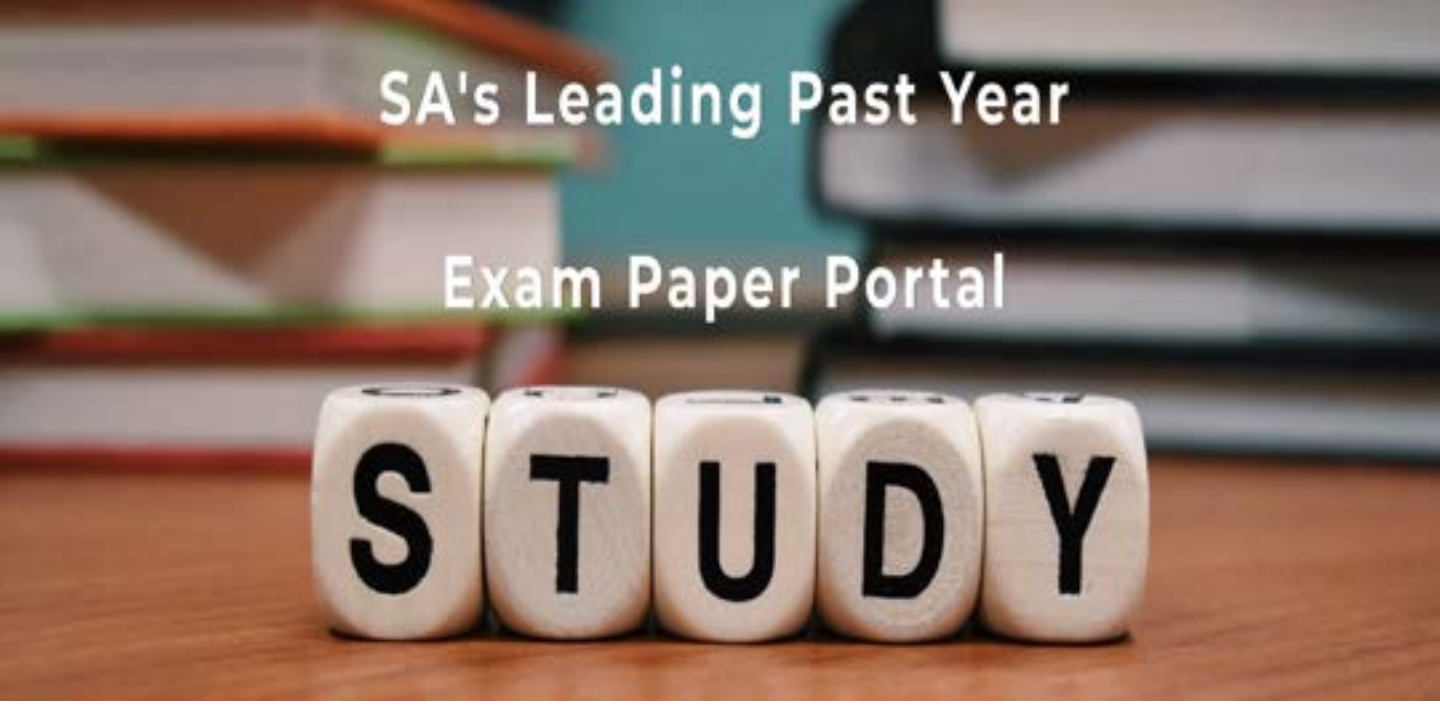

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GRADE 12

MECHANICAL TECHNOLOGY

FEBRUARY/MARCH 2013

MEMORANDUM

MARKS: 200

This memorandum consists of 17 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

[20]

QUESTION 2: TOOLS AND EQUIPMENT

2.1 **Gas Analyzer**
CO (Carbon Monoxide) and hydrocarbon ✓✓ (2)

2.2 **Hardness** is the resistance against scratching, denting and wear. ✓✓ (2)

2.3 **Hardness testers:**
- Brinell hardness tester ✓
- Rockwell hardness tester ✓
- Vickers ✓

(**Any 2 x 1 = 2)** (2)

2.4 **Compression tester:**
- Check for worn cylinders ✓
- Check for worn piston rings ✓
- Check for worn pistons ✓
- Check for inlet valve leakage ✓
- Check for exhaust valve leakage ✓
- Leaking cylinder head gasket ✓

(Any 3 x 1=3) (3)

2.5 **Cylinder leakage tester:**
- 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. ✓
- Listen for a hissing noise at the oil filler hole. ✓ Rings are worn ✓
- Air bubbles in the radiator water.✓The cylinder head gasket is blown.✓

(Any 3 x 2=6) (6)

2.6 **Tensile Tester**
A tensile tester measures the resistance of a material to a static or slowly applied tensile axial force. ✓✓ (2)

2.7 **Beam bending test**
Beam bending test is to investigate the deflection of beams. ✓
To see if the beam is safe enough to support the load. ✓ (2)

2.8 **MIGS – abbreviation**:
Metal Inert Gas Shielded ✓ (1)

[20]

QUESTION 3: MATERIALS

3.1 **Reasons for manufacturing alloys:**

- Creating a harder, tougher metal ✓
- Producing a stronger metal ✓
- Increasing 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 and tear ✓
- Lowering the cost of the metal ✓
- Lowering the melting point to below the mean of the metal components ✓ **(Any 3 x 1=3)** (3)

3.2 **Advantages of thermoplastics:**

- Thermoplastics lend themselves to rapid moulding and extrusion processes ✓
- There is no wastage ✓
- All scrap flashing and rejects can be used again ✓

(Any 2 x 1=2) (2)

3.3 **Tin and lead bases in white metal:**

- The tin-base white metal is used in heavy duty bearings to withstand greater pressures and speed ✓
- Lead-based metals are used under less demanding conditions ✓ (2)

3.4 **Use of flux:**

Flux is used to ensure that the solder flows over a chemically clean surface ✓ (1)

3.5 **Advantages of silver solder:**

- It has a higher melting point and variety of applications ✓
- It is resistant to corrosion ✓ (2)

3.6 **Purpose of using certain materials:**

3.6.1

- P.V.C. is not a good conductor of electricity and corrosion resistant ✓
- It can be obtained in a range of colours and sizes ✓ (2)

3.6.2

- Copper wire is used because it is a good conductor of electricity and will resist corrosion ✓
- It is also very soft and malleable ✓ (2)

3.7 **Reasons for working materials in liquid form:**

- Components can be made easily and cheaply without the need for expensive machine ✓
- Complex shapes can be made without the need of complicated machining processes ✓ (2)

3.8 **Nylon:**

3.8.1 **Properties of Nylon:**

- Needs no lubrication ✓
- Can withstand shock ✓
- Low maintenance ✓
- Light in weight ✓
- Easy to machine ✓

(Any 2 x 1=2) (2)

3.8.2 **Uses of Nylon**

- Fan blades ✓
- Bearings ✓
- Gears ✓
- Trolley wheels ✓
- Sliding plates ✓
- Bolts and nuts ✓

(Any 2 x 1=2) (2)
[20]

QUESTION 4: SAFETY, TERMINOLOGY AND JOINING METHODS

4.1 **Tensile tester:**

- Use safety goggles to protect eyes ✓
- Do not apply excessive pressure ✓
- Work piece to be well secured for testing ✓
- Check the hydraulic fluid level ✓

(Any 3 x 1=3) (3)

4.2 **Multi-meter:**

- Keep the meter dry ✓
- Keep the meter away from dust and dirt ✓
- Use and store the meter in normal temperature environment ✓
- Do not drop the meter ✓
- Use only charged cells of the correct size. ✓

(Any 3 x 1=3) (3)

4.3 **Lathe:**

4.3.1 **Chuck:**

- Keep hands from rotating chuck ✓
- Don't leave the chuck key in the chuck ✓
- Make sure the chuck is well secured before switching on the machine ✓
- Place some protection on the bed while changing chucks ✓
- Turn the chuck by hand to be certain that there is no danger of the work piece striking any part of the lathe ✓
- Be careful not to run the cutting tool into the chuck ✓

(Any 1 x 1) (1)

4.3.2 **Machine guard:**

- Make sure the guard is well secured before switching on the machine ✓
- Machine guard must be in a good condition ✓

(Any 1 x 1) (1)

4.3.3 **Tail stock:**

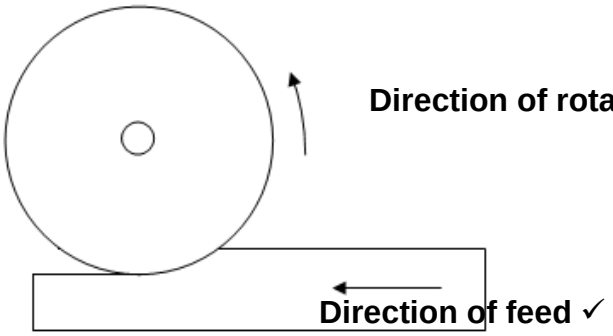
- Make sure the centre or drill chuck is well secured before switching on the machine ✓
- Make sure the tail stock is well secured and locked when cutting between centres ✓

(Any 1 x 1) (1)

4.4 **Indexing:**

4.4.1 Gear cutter or involute cutter ✓ (1)

4.4.2



(2)

4.4.3 **Indexing:**

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

$$= \frac{40}{100} \quad \checkmark$$

$$= \frac{2 \times 5}{5 \times 5}$$

$$= \frac{10}{25} \text{ or } \frac{12}{30} \quad \checkmark$$

10 Holes on a 25 Hole circle ✓ (4)

4.4.4 **Change gears: (any of the other formulae are acceptable)**

$$\frac{D_r}{D_v} = (N - n) \times \frac{40}{N} \quad \checkmark$$

$$\frac{D_r}{D_v} = (100 - 97) \times \frac{40}{100} \quad \checkmark$$

$$= \frac{120}{100} \quad \checkmark$$

$$= \frac{6 \times 8}{5 \times 8} \quad \checkmark$$

$$= \frac{48}{40} \quad \checkmark$$

(5)

4.5 **Advantages of helical cutters:**

- Chattering is reduced ✓
- Helps to remove shavings ✓
- Continuous forming of shavings is prevented ✓
- Better cutting action ✓
- Finishing on the work piece is improved ✓
- Coolant flow is easier ✓

(Any 2x1 = 2) (2)

4.6 **Feed in mm/min:**

$Feed = f_1 \times T \times N$ ✓

$Feed = 0,04 \times 30 \times 400$ ✓

$= 480 \ mm/min$ ✓ (3)

4.7

4.7.1 **Dedendum:**

$Dedendum = 1,25 \times m$ OR $Dedendum = 1,157 \times m$

$Dedendum = 1,25 \times 2,5$ ✓ $Dedendum = 1,157 \times 2,5$

$= 3,125 \ mm$ ✓ $= 2,89 \ mm$ (2)

4.7.2 **Gear ratio:**

$$Gear\ ratio = \frac{Product\ of\ number\ of\ teeth\ on\ the\ driven\ gears}{Product\ of\ number\ of\ teeth\ on\ the\ driving\ gears}$$

$$Gear\ ratio = \frac{50 \times 60}{25 \times 30}$$ ✓

$Gear\ ratio = 4 : 1$ ✓ (3)

4.7.3 **PCD:**

$PCD = m \times T$

$= 2,5 \times 25$ ✓

$= 62,5mm$ ✓ (3)

4.7.4 **Outside diameter:**

$Outside\ Diameter = PCD + 2m$

$= 62,5 + 2\ x\ 2,5$ ✓

$= 67,5mm$ ✓ (2)

4.7.5 **Circular pitch:**

$Circular\ Pitch = \pi\ x\ m$

$= \pi\ x\ 2,5$ ✓

$= 7,85\ mm$ ✓ (3)

4.8 **Advantages of MIG/MAG:**

- Suitable for thin metals ✓
- Can weld continuously ✓
- Minimal post weld cleaning is required ✓
- Can weld in any position ✓

(Any 3x1=3) (3)

4.9

WELDING FLAW	ONE CAUSE	NON – DESTRUCTIVE TEST
Cracks	• Rapid cooling ✓ • Base metal not weldable ✓ • Wrong weld technique. Weld too small ✓ **(Any 1x1)**	Liquid dye test ✓ Visual test ✓ **(Any 1x1)**
Poor fusion	• Current too low ✓ • Welding technique wrong ✓ • Joint preparation wrong. ✓ • Wrong electrode size ✓ **(Any 1x1)**	Visual test ✓
Porosity	• Atmospheric contamination ✓ • Surface contamination ✓ • Dirty or wet electrodes ✓ • Rusted MIG wire ✓ **(Any 1x1)**	X- ray test ✓
Undercutting	• Current too high ✓ • Wrong manipulation ✓ • Arc length too long ✓ • Welding speed too high ✓ **(Any 1x1)**	Visual test ✓

(2) (2) (2) (2)

[50]

QUESTION 5: MAINTENANCE AND TURBINES

5.1 **Pour point** is the lowest temperature at which a liquid remains fluid or 'pourable' ✓✓ (2)

5.2 **Cutting fluids:**

- Avoid contamination of the cutting fluid by draining and regularly replacing it ✓
- Always clean the machine's splash tray of metal cutting after use ✓
- Regularly wipe clean fluid splashes of the machine parts (Only when machine is stationary) ✓
- Ensure that the sump is topped up from time to time, and check that there is sufficient flow of cutting fluid to the cutting tool ✓

(Any 3x1=3) (3)

5.3 **Cutting fluids:**

- Acts as a lubricant ✓
- Improve surface finish ✓
- To keep the work piece cool ✓
- To keep the cutting tool cool ✓
- To obtain a higher cutting speed ✓
- It gives the cutting tool a longer lifespan ✓
- Prevent rust ✓
- Wash away the chips ✓

(Any 4x1=4) (4)

5.4 **Changing engine oil:**

- Formation of gum, acids and lacquer may be left by the combustion of the fuel ✓
- Oil loses its viscosity due to excessive heat ✓
- Metal particles deposit in the oil due to metal on metal contact ✓

(Any 2x1=2) (2)

5.5 **Fitting oil filter:**

- Use a filter strap spanner and remove old oil filter ✓
- Clean the filter area and lightly oil the mating surfaces ✓
- Put a smear of clean engine oil on the seal of the filter ✓
- Screw the filter into engine block ✓
- Tighten filter by hand ✓ (5)

5.6 **Causes of 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 torqued according to specification, too tight ✓
- Load on bearing excessive ✓
- Uneven bearing surfaces ✓
- Poor assembly of bearing shells ✓

(Any 4x1=4) (4)

5.7 **Steam turbines:** are operated by using steam that creates kinetic energy to generate rotational motion that is mechanical energy ✓✓ (2)

5.8 **Classes of turbines:**

- Impulse turbine ✓
- Reaction turbine ✓ (2)

5.9 **Turbocharger:**

- The hot exhaust gases ✓
- are routed to the turbine wheel to enable the wheel to spin at very high speeds ✓
- The gases are then channelled out 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 impeller ✓
- The impeller and its housing acts as a compressor drawing air in through the inlet ✓
- and delivering it under pressure through the outlet into the cylinders which increases the volumetric efficiency ✓ (6)

5.10 **Advantages of gas turbines:**

- High power output from the given weight of engine ✓
- The torque output characteristic permits a simplification of the transmission system ✓
- Smooth vibration less running 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 giving very little trouble with pollution ✓
- Requires little routine maintenance ✓ **(Any 4x1=4)** (4)

5.11 **Boost** refers to the increase in manifold pressure that is generated by the turbocharger in the intake path that exceeds the normal atmospheric pressure ✓✓ (2)

5.12 **Advantages of a supercharger:**

- More power is obtained compared to a similar vehicle without supercharger ✓
- Supercharged engines are more economical per given kilowatt output ✓
- Less fuel is used compared to engine mass ✓
- Power loss is eliminated above sea level ✓

(Any 2x1=2) (2)

5.13 **Disadvantages of a supercharger:**

- A small amount of power is lost in order to drive the supercharger because it uses the engine power to drive it ✓
- Higher fuel consumption results if the power generated is not fully used, as in the case of passenger vehicles ✓
- Owing to the compression of the air this results in an increase in temperature causing a decrease in the density of the inlet charge ✓
- The lifespan of the engine is decreased because of higher cylinder pressure, which increases the load on the engine components ✓

(Any 2x1=2) (2)

[40]

QUESTION 6 FORCES AND SYSTEMS AND CONTROL

6.1 **Stress and Strain:**

6.1.1 Tensile stress ✓✓ (2)

6.1.2 **Stress:**

$$\sigma = \frac{F}{A} \quad ✓$$

$$= \frac{2{,}5\times10^{3}}{8{,}08\times10^{-3}} \quad ✓$$

$$= 0{,}31\times10^{6}\ Pa \ \ or \ \ = 309405{,}94\ Pa$$

$$= 0{,}31\ MPa \quad ✓$$

(3)

6.1.3 **Strain:**

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

$$= \frac{0{,}391\times10^{-3}}{3{,}08} \quad ✓$$

$$= 0{,}13\times\ 10^{-3}\ \ or\ \ 0{,}00012694 \quad ✓$$

(3)

6.1.4 **Elasticity modulus:**

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

$$= \frac{0{,}31\times10^{6}}{0{,}13\times10^{-3}} \quad ✓$$

$$= 2{,}38\times10^{9}\ or\ 2437265184\ Pa \quad ✓$$

$$= 2{,}44\ GPa$$

(3)

6.2 Gear drives:

6.2.1 Number of teeth on driven gear:

$$N_B T_B = N_A T_A \quad \checkmark$$

$$T_B = \frac{N_A T_A}{N_B} \quad \checkmark$$

$$= \frac{660 \times 50}{1000} \quad \checkmark$$

$$= 33 \text{ teeth} \quad \checkmark$$

(4)

6.2.2 Rotation frequency of the driven gear:

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

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

$$= \frac{660 \times 50}{60} \quad \checkmark$$

$$= 550 \text{ rpm} \quad \checkmark$$

OR

$$N_B T_B = N_C T_C \quad \checkmark$$

$$N_C = \frac{N_B T_B}{T_C} \quad \checkmark$$

$$= \frac{1000 \times 33}{60} \quad \checkmark$$

$$= 550 \text{ rpm} \quad \checkmark$$

(4)

6.2.3 Clockwise ✓✓ (2)

6.3 Belt drives:

6.3.1 Diameter driven pulley:

$$N_{DV}D_{DV} = N_{DR}D_{DR} \quad \checkmark$$

$$D_{DV} = \frac{N_{DR}D_{DR}}{N_{DV}} \quad \checkmark$$

$$= \frac{7{,}2 \times 600}{10} \quad \checkmark$$

$$= 432\ mm \quad \checkmark \qquad (4)$$

6.3.2 Power transmitted:

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

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

$$= \frac{300}{2{,}5}$$

$$= 120\ N \quad \text{———} \checkmark$$

$$P = (T_1 - T_2)\ x\ \pi\ x\ D\ x\ n \quad \text{———} \checkmark$$

$$= (300 - 120)\ x\ \pi\ x\ 0{,}6\ x\ 7{,}2 \quad \text{—} \checkmark$$

$$= 2\,442{,}90\ Watt$$

$$= 2{,}44\ kW \quad \text{———} \checkmark \qquad (6)$$

6.4 Hydraulics:

6.4.1 Pressure:

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

$$= \frac{\pi(0,036)2}{4}$$

$$= 1,02 \times 10^{-3}\ m^2 \text{ or } 0,001017876\ m^2 \quad \checkmark$$

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

$$= \frac{0,85 \times 10^3}{1,02 \times 10^{-3}} = 835072,23\ Pa \quad \checkmark$$

$$= 0,83\ MPa \quad \checkmark$$

(5)

6.4.2 Number of strokes:

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

$$= \frac{\pi(0,225)^2}{4}$$

$$= 39,76x10^{-3}\ m^2 \text{ or } 0,039760782\ m^2 \quad \checkmark$$

$$V_A = V_B \quad \checkmark$$

$$A_A\ x\ L_A = A_B\ x\ L_B$$

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

$$= \frac{39,76\ x\ 10^{-3}\ x\ 33,86\ x\ 10^{-3}}{1,02\ x\ 10^{-3}} \quad \checkmark$$

$$= 1,32\ m \text{ or } 1,322656\ m \quad \checkmark$$

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

$$= \frac{1,32}{0,11} \quad \checkmark$$

$$= 12\ strokes \quad \checkmark$$

(9)

6.5 **Effective diameter:**

$T = \mu WnR$ ——————————— ✓

$R = \dfrac{T}{\mu Wn}$ ——————————— ✓

$= \dfrac{220}{0{,}4 \text{ x } 2{,}8 \text{ x } 10^3 \text{ x } 2}$ ——————————— ✓

$= 0{,}098 \text{ m or } 0{,}098214285 \text{ m}$

$Eff \text{ diameter} = R \text{ x } 2$ ✓

$= 0{,}098 \text{ x } 2$ ———————

$= 0{,}2 \text{ m or } 0.196428571 \text{ m}$

$= 200 \text{ mm}$ ——————— ✓

(5)
[50]

TOTAL: 200