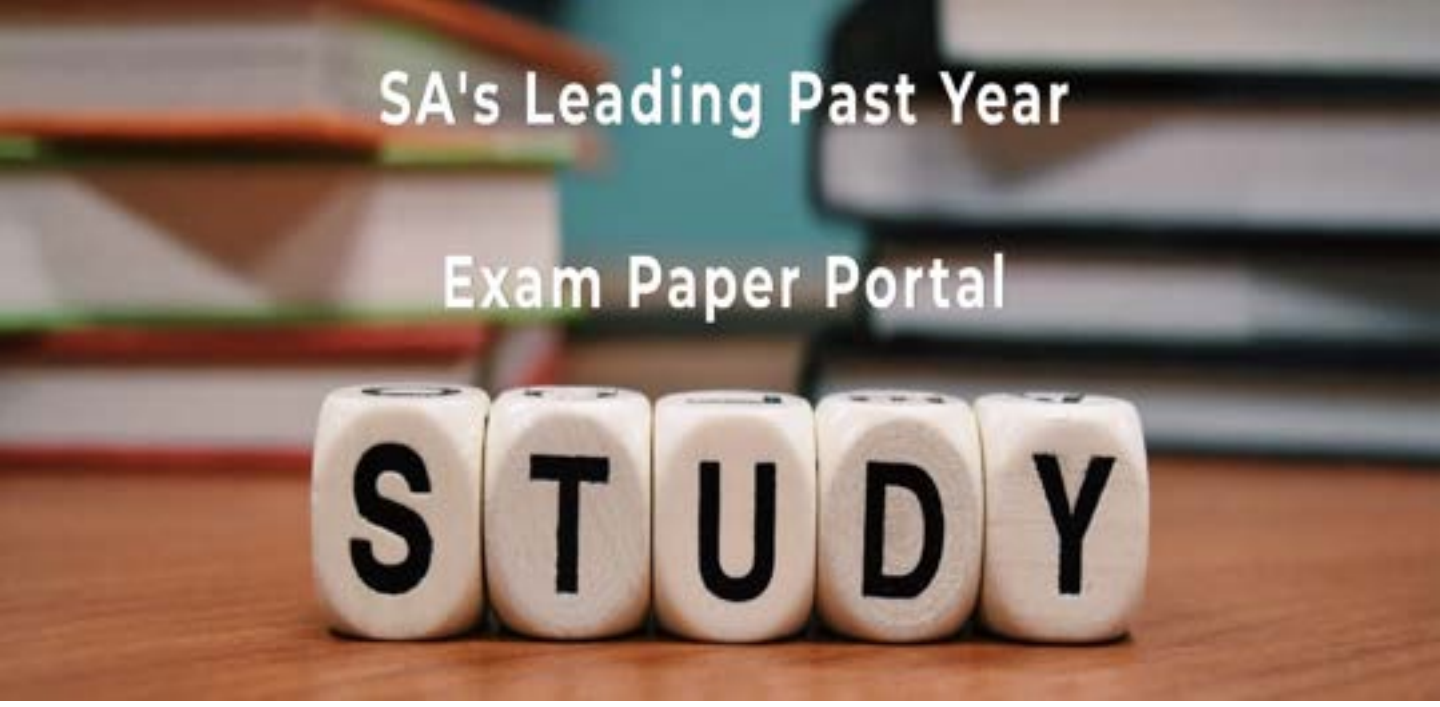

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GRADE 12

SEPTEMBER 2020

MECHANICAL TECHNOLOGY: AUTOMOTIVE MARKING GUIDELINE

MARKS: **200**

This marking guideline consists of 15 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 C ✓ (1)

1.2 B ✓ (1)

1.3 C ✓ (1)

1.4 A ✓ (1)

1.5 B ✓ (1)

1.6 C ✓ (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Gas welding (PPE)**

- Eye protection ✓
- Overall / leather apron ✓
- Safety boots ✓
- Gloves ✓

(Any 2 x 1) (2)

2.2 **Safety rules that must be followed whilst the surface grinder is in operation:**

- Make sure that the sparks are of no danger to co-workers. ✓
- Do not force the material onto the grinding wheel. ✓
- Do not plunge grind. ✓
- Bring the material slowly into contact with the grinding wheel. ✓
- Never clean or adjust the machine whilst it is in motion. ✓
- Use cutting fluid. ✓
- Know where the emergency stop is located. ✓
- Stop the machine before any adjustment. ✓
- Keep tools clear from moving parts. ✓

(Any 2 x 1) (2)

2.3 **Completing a task on any machine:**
Switch the machine off. ✓ (1)

2.4 **TWO safety measures to observe before switching the angle grinder on:**

- Make sure that there are no cracks or chips on the disc. ✓
- Make sure that the emery disc that is fitted is rated above the revolutions at which it is turned by the motor. ✓
- Make sure that the space between the tool rest and the emery disc does not exceed 3 mm. ✓
- Ensure that guards are in place. ✓
- Do not stand in front of the machine when switching it on; wait until it reaches its full speed. ✓
- Do not force or bump the work piece against the emery disc. ✓
- Grind only on the front surface of the wheel, not the sides. ✓
- All grinding machines must have a sign indicating the revolutions at which the spindle rotates. ✓ (Any 2 x 1) (2)

2.5 **Importance of a welding helmet:**

- To protect your eyes and face from ultra-violet rays and radiation ✓ (1)

2.6 **Types of workshop layouts:**

- Process layout ✓
- Product layout ✓ (2)

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QUESTION 3: MATERIALS (GENERIC)

3.1

MATERIALS	DIFFERENT TYPES OF TESTS		
	Sound	**Filing**	**Bend**
Cast iron	Very dull sound ✓	Easy ✓	Cannot bend ✓/ Snaps/breaks✓/ Fracturea easily ✓
Mild steel	Medium metallic sound ✓	Easy ✓	Benda easily ✓

(6)

3.2 **Heat treatment process:**

- Is the heating and cooling of metals in their solid state so as to change their properties ✓ (1)

3.3 **Hardness factors:**

- Workpiece size ✓
- Quenching rate ✓
- Carbon content ✓ (Any 2 x 1) (2)

3.4 **Heat treatment processes:**

3.4.1 **Tempering**

- Is a process applied to steel and it relieves the strains induced during the hardening process. ✓
- It decreases the degree of hardness ✓
- It increases toughness ✓
- It reduces brittleness ✓
- It gives steel fine grain structure ✓ (Any 2 x 1) (2)

3.4.2 **Annealing**

- Relieves internal stress ✓
- Softens the metal ✓
- Makes metal ductile ✓
- Refines the grain structure ✓
- Reduces brittleness ✓ (Any 2 x 1) (2)

3.5 **Hardness of steel depends upon**

- Carbon content ✓ (1)

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QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1	A ✓	(1)
4.2	C ✓	(1)
4.3	D ✓	(1)
4.4	B ✓	(1)
4.5	B ✓	(1)
4.6	D ✓	(1)
4.7	C ✓	(1)
4.8	D ✓	(1)
4.9	B ✓	(1)
4.10	A ✓	(1)
4.11	C ✓	(1)
4.12	D ✓	(1)
4.13	B ✓	(1)
4.14	A ✓	(1)

[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Bubble gauge:**

5.1.1
- Bubble gauge ✓ (1)

5.1.2
A – King-pin inclination scale ✓
B – Caster scale ✓
C – Camber scale ✓
D – Gauge zero scale ✓
E – Mounting equipment on wheel ✓ (5)

5.1.3
- Caster angle ✓
- Camber angle ✓
- King-pin inclination ✓ (3)

5.2 **Set-up procedure to read camber:**
- Ensure that the wheels are in a straight ahead position. ✓
- Mount the bubble gauge on the centre of the wheel. ✓
- Zero the bubble gauge on the gauge zero scale. ✓
- Take the reading on the camber scale. ✓
- Do the same for the other wheels. ✓ (5)

5.3 **Dynamic balancing of wheels:**
- The plane of imbalance ✓
- The extent of unbalanced forces ✓
- The sense of direction of these forces (clockwise or counter clockwise / anticlockwise) ✓
- Run-out of the tyre and wheel assembly ✓ (Any 3 x 1) (3)

5.4 **Tools:**

5.4.1 **Turn table:**
To turn the front wheel 20˚ in and zero the bubble gauge ✓ and then turn the wheel 20˚ out to check the castor reading ✓ (2)

5.4.2 **Wheel balancer:**
To balance the wheels of a vehicle ✓ for static and dynamic balance. ✓ (2)

5.4.3 **Optical alignment tool:**
To check the toe-in ✓ and toe-out of a vehicle ✓ (2)

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QUESTION 6: ENGINES (SPECIFIC)

6.1 **Causes of vibration:**
- The action of unbalance forces upon the shaft ✓
- The twisting effects of the power stroke ✓ (2)

6.2 **Types of vibration damper:**
- Friction face-type ✓
- Combined rubber and friction disc ✓ (2)

6.3 **In-built engine balance features:**

6.3.1 Crankshafts are carefully balanced with webs extended and drilled to form balance mass piece at points opposite the connecting rods. ✓✓ (2)

6.3.2 Connecting rods and pistons are kept as light as possible to reduce reciprocating forces. ✓✓ (2)

6.3.3 Flywheels are carefully balanced and are usually fitted to the crankshaft flange in one position only. ✓✓ (2)

6.4 **Factors that determine engine configuration:**
- Number of cylinders ✓
- Position of cylinders ✓
- Engine layout ✓
- Firing order ✓
- Engine location and mounting ✓ (Any 3 x 1) (3)

6.5 **Types of engine configuration:**
- In-line engine ✓
- V-type engine ✓
- Horizontally opposed engine ✓ (Any 2 x 1) (2)

6.6 **Identification of an engine configuration:**
The crankshaft of a V-engine ✓ (1)

6.7 **Factors that determine the firing order:**
- The position of the crank on the crankshaft ✓
- The arrangement of the cams on the camshaft ✓ (2)

6.8 **Firing order of a 5-cylinder in-line engine:**
12453 **OR** 13542 ✓ (1)

6.9 **Turbocharger internal components:**
A – Turbine exhaust gas outlet ✓
B – Turbine wheel **OR** impeller ✓
C – Turbine exhaust gas inlet ✓
D – Compressor air discharge ✓
E – Compressor ✓
F – Compressor air inlet ✓ (6)

6.10 **Disadvantages of a turbocharger:**

- It can have lag problems. ✓
- It tends to heat up the air, reducing density. ✓
- Some require shut-down process. ✓
- It requires pressure lubrication for high speed bearings. ✓
- Its lubricant must be air cooled. ✓
- Over-revving must be controlled by waste gate. ✓

(Any 3 x 1) (3)

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QUESTION 7: FORCES (SPECIFIC)

7.1 **Compression ratio:**
The compression ratio of an internal combustion engine is the ratio of compression of the inlet charge during the compression stroke ✓ to the total volume of the cylinder. ✓ (2)

7.2 **Compression ratio:**
Swept volume:

$Swept\ volume = \frac{\prod D^2}{4} L$ ✓

$= \frac{\prod(9.0^2)}{4} \times 11$ ✓

= 700 cm^3 ✓

Compression ratio = $\frac{SV+CV}{CV}$ ✓

= $\frac{700+70}{70}$ ✓

11 : 1 ✓ (6)

7.3 **New compression ratio:**

Swept volume $= \frac{\prod(9{,}61^2)}{4} \times 11$

= 797,865 cm^3 ✓

Compression ration = $\frac{797{,}865 + 70}{70}$ ✓

=12,4 : 1 ✓ (4) (4)

7.4 **Methods used in raising compression ratio:**

- Remove shims between the cylinder block and cylinder head. ✓
- Fit thinner cylinder head gasket. ✓
- Machine metal from cylinder head. ✓
- Skim metal from cylinder block. ✓
- Fit piston with higher crown. ✓
- Fit crankshaft with longer stroke. ✓
- Increase the bore of the cylinders. ✓ (Any 4 x 1) (4)

7.5 **Indicated power:**
Indicated power is a measure to determine the total power developed by the burning of fuel in the combustion chamber of an internal combustion engine. ✓✓ (2)

7.6 **Power calculations:**

7.6.1 Indicated power = P × L × A × N × n

P = 1200000 Pa

$L=\frac{86}{1000}$

=0,086 m ✓

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

$= \frac{\pi \times 0{,}09^2}{4}$ ✓

$=6{,}36 \times 10^{-3}\ m^2$ ✓

$N = \frac{4200}{60\times2}$ ✓

= 35 r/s ✓

N = 4 cylinders

Indicated power = 1200000 × 0,086 × 6,36 × 10^{-3} × 35 × 4✓

= 91889,28 W
= 92 kW ✓ (7)

7.6.2 Brake power = 2 π NT

$N = \frac{4200}{60}$

70 r/s ✓

= 2 × π × 70 × 180 ✓
=211115,03 W

=79168,13 W
=79,2 kW ✓

(3)

7.6.3 Mechanical efficiency = $\frac{BP}{IP} \times 100\%$

$= \frac{79,2}{92} \times 100\%$ ✓

= 82,5% ✓ (2)

7.7 **Term definition:**
It is the percentage energy that an engine puts out due to mechanical losses as compared to the ideal engine power. ✓✓ (2)

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QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Reasons for high CO (carbon monoxide) reading:**

8.1.1
- Too rich mixture ✓
- Ignition misfire ✓
- Dirty or restricted air filter ✓
- Improper operation of the fuel delivery system ✓
- Faulty thermostat or coolant sensor ✓
- Non-functioning PVC valve system ✓
- Catalytic converter not working ✓ (Any 3x1) (3)

8.1.2 **Corrective measures:**
- Reset fuel mixtures. ✓
- Check for misfire and repair. ✓
- Replace air filter. ✓
- Check and correct fuel delivery system. ✓ (Any 3 x 1) (3)

8.1.3 **Gases analysed:**
- CO_2 ✓
- SO_2 ✓
- NO ✓
- HC ✓
- O_2 ✓ (Any 3 x 1) (3)

8.2 **Cylinder leakage testing:**
- Wet test ✓ (1)

8.3 **Cylinder leakage and causes:**

8.3.1 Leakage inlet valve ✓ (1)

8.3.2 Blown cylinder head gasket or cracked cylinder block ✓ (1)

8.3.3 Piston rings are worn ✓ (1)

8.4 **Oil pressure testing:**
- Oil pressure when the engine is idling. ✓
- Oil pressure when the engine is cold. ✓
- Oil pressure when the engine is hot. ✓
- Oil pressure on high revolution. ✓ (4)

8.5 **Causes of low fuel pressure reading:**

- Faulty fuel pump ✓
- Blocked or restricted fuel filter ✓
- Cracked or restricted fuel line ✓
- Clogged pump inlet strainer ✓
- Low voltage to fuel pump ✓
- Faulty fuel pressure regulator ✓
- Faulty fuel pump relay ✓
- Empty fuel tank ✓ (Any 3 x 1) (3)

8.6 **Cooling system pressure testing:**

- Water hoses ✓
- Water pump ✓
- Radiator ✓
- Corroded core plugs ✓
- Interior heater radiator ✓
- Faulty radiator cap ✓ (Any 3 x 1) (3)

[23]

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX) (SPECIFIC)

9.1 **Purpose of automatic gearbox:**
To relieve the driver of clutch and gearshift operation✓, thereby allowing the driver to concentrate on driving the vehicle ✓ (2)

9.2 **Advantages of an automatic gearbox**
- It reduces driving fatigue. ✓
- It ensures reduction of wheel spin under bad road condition. ✓
- The vehicle can be stopped suddenly without the engine stalling✓
- The system puts a damper on/muffles all engine vibrations. ✓
(Any 3 x 1) (3)

9.3 **Torque converter:**
9.3.1 Torque converter ✓ (1)

9.3.2 **Parts**
A – One-way clutch ✓
B – Turbine ✓
C – Pump ✓
D – Turbine shaft ✓
E – Gearbox housing ✓ (5)

9.3.3 **Torque converter functions:**
- Transfers engine torque to the transmission. ✓
- Multiplies the engine torque. ✓
- Provides a direct drive from engine to transmission. ✓
- It muffles/puts a damper on all engine vibrations. ✓
- It acts as flywheel. ✓ (Any 3 x1) (3)

9.3.4 **Function of parts:**
It sets the fluid in motion at high pressure to the turbine, ✓ thereby causing the turbine to rotate with great torque. ✓ (2)

9.4 **Torque multiplication:**
As the car speed increases, ✓ the torque multiplication tapers off gradually. ✓ (2)

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QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS) (SPECIFIC)

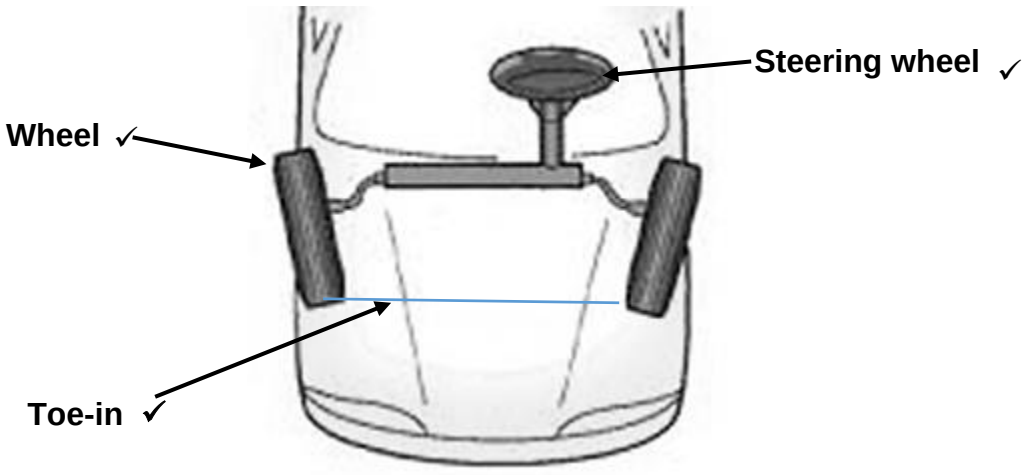
10.1 **Properties of a good steering mechanism:**

- Light and easy to control ✓
- Free from vibration and road shocks ✓
- Self-centring ✓
- Able to operate effectively under the influence of the suspension and braking system ✓
- It must be as direct as possible to reduce too much driver's attention. ✓

(Any 4 x 1) (4)

10.2

Toe-in



(4)

10.3 **Alignments:**

10.3.1 **Caster angle:**
It gives self-centring action to the steering✓ thereby keeping the wheels in straight ahead position.✓ (2)

10.3.2 **Ackermann principle:**
To avoid the need for tyres to slip sideways ✓ when following the path around a curve.✓ (2)

10.3.3 **King pin inclination:**
To bring the front wheel back to the straight ahead position ✓ after rounding a corner without any driver effort. ✓ (2)

10.4 **Camber:**

10.4.1 Positive camber. ✓ (1)

10.4.2 A – Tyre ✓
B – Vertical line ✓
C – Centre line ✓
D – Positive camber angle ✓
E – Lower control arm ✓
F – Road surface ✓ (6)

10.4.3 Positive camber angle is the outward tilt ✓ of a front wheel away from The vehicle when viewed from the front. ✓ (2)

10.5 **Factors to be taken into account before attempting alignment adjustment:**

- Kerb mass must be checked against the manufacturer's specifications ✓
- Uneven wear on tyres ✓
- Tyre pressure ✓
- Run-out on wheels ✓
- Kingpins and bushes ✓
- Suspension ball joints for wears ✓
- Suspension bushes for excessive free movements ✓
- Tie-rod ends ✓
- Sagged springs ✓
- Ineffective shock absorbers ✓
- Spring U-bolts ✓
- Chassis for possible cracks ✓
- Wheel must be balanced ✓
- Wheel alignment specifications ✓
- Drive shaft CV-joints ✓ (Any 5 x 1) (5)

10.6 **Purpose of wheel balancing:**

To avoid shimming and bouncing of wheel assembly which can cause wearing of the steering mechanism and suspension parts. ✓✓ (2)

10.7 **Wheel balancing:**

- Static balance ✓
- Dynamic balance ✓ (2)

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TOTAL: 200