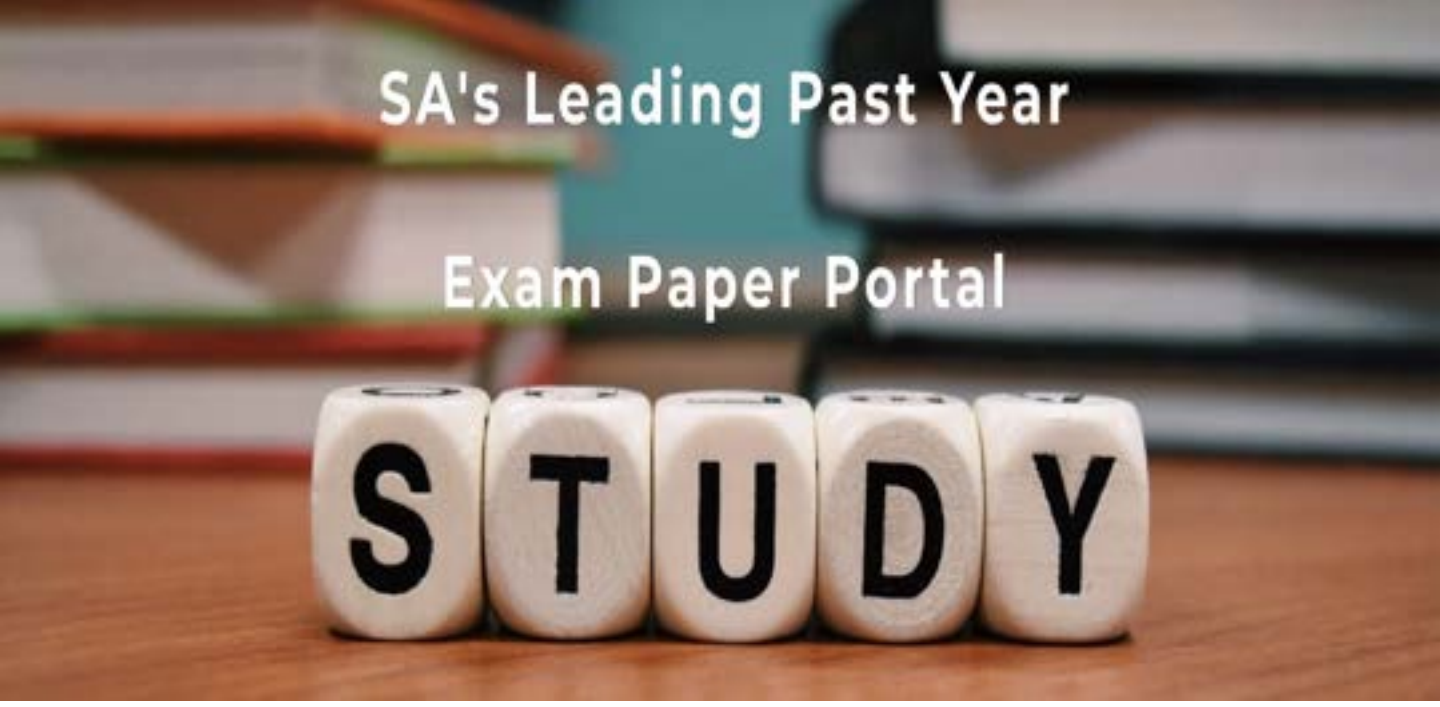

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GRADE 12

SEPTEMBER 2022

MECHANICAL TECHNOLOGY: AUTOMOTIVE MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 11 pages.

SECTION A: COMPULSORY

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 D ✓
1.2 B ✓
1.3 A ✓
1.4 C ✓
1.5 C ✓
1.6 B ✓

(6 x 1) **[6]**

QUESTION 2: SAFETY (GENERIC)

2.1 **Personal protective equipment**

- Welding helmet ✓
- Leather apron ✓
- Leather hand gloves ✓
- Overall/work suit ✓
- Safety boot ✓ (Any 3 x 1) (3)

2.2 **Arc welding safety precautions**

- Wear correct PPE ✓
- The welding cables and electrode holder must be well insulated ✓
- Your eyes must be protected with a welding helmet before attempting any strike ✓
- Ensure that there is no water in the environment ✓
- Keep away combustible materials from the welding area ✓ (Any 3 x 1) (3)

2.3 **Reason why you must not force drill bit into the workpiece**

- It can cause a broken drill bit and possible injuries. ✓ (1)

2.4 **Reason for clamping a small workpiece before drilling**

- To avoid slipping ✓
- Prevent drill bit from getting broken ✓
- To ensure smooth and straight drilling ✓ (Any 1 x 1) (1)

2.5 **Safety precautions to be observed when handling gas cylinders**

- Store or transport cylinders in an upright position ✓
- Avoid oil or grease from coming in contact with oxygen fittings ✓
- Never stack cylinders on top of one another ✓
- Do not bang or work on cylinders ✓
- Never allow cylinders to fall ✓ (Any 2 x 1) (2)

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QUESTION 3: MATERIALS (GENERIC)

3.1 3.1.1 **Test required to determine the carbon content of a metal**
- Sound test ✓
- Spark test ✓ (Any 1 x 1) (1)

3.1.2 **Test required to determine the ductility of metal**
- Bending test ✓ (1)

3.2 **Cutting colour coded metals from unmarked end**
- In order to keep its identity ✓ (1)

3.3 **Types of case-hardening**
- Carburising ✓
- Nitriding ✓
- Cyaniding ✓ (3)

3.4 **Effect of medium or high carbon steel on case-hardening**
- The hardness will penetrate the core of the steel ✓ (1)

3.5 **Heat treatment process of metal**
It has to do with heating metal to the required temperature, ✓ allow to soak in that temperature for a given period of time, ✓ then cool in the appropriate medium. ✓ (3)

3.6 **Factors that determine the hardness of steel during heat treatment**
- Work size ✓
- Quenching rate ✓
- Carbon content ✓ (3)

3.7 **Properties achieved from an annealed steel**
- Softness ✓
- Ductility ✓ (Any 1 x 1) (1)

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QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1 C ✓
4.2 A ✓
4.3 B ✓
4.4 B ✓
4.5 D ✓
4.6 D ✓
4.7 A ✓
4.8 C ✓
4.9 C ✓
4.10 A ✓
4.11 B ✓
4.12 A ✓
4.13 D ✓
4.14 C ✓ (14 x 1) **[14]**

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 5.1.1 **Equipment identification**
Bubble gauge ✓ (1)

5.1.2 **Parts labelling**
A – King pin inclination scale ✓
B – Caster angle ✓
C – Camber angle ✓
D – Mounting equipment on wheel ✓ (4)

5.1.3 **Purpose of a bubble gauge**
It is used to test caster, ✓ camber ✓ and king pin inclination angles of a motor vehicle. ✓ (3)

5.2 **Parts labelling of periscopic optical alignment tool**
1 – Contact ✓
2 – Mirror gauge ✓
3 – Periscope ✓
4 – Periscope gauge ✓
5 – Height slot/Height bar ✓
6 – Toe gauge ✓
7 – Calculator ✓
8 – Stand ✓ (8)

5.3 **Function of optical alignment tool**
It makes it possible to check toe-in and toe-out of a vehicle. ✓ (1)

5.4 **Card type compression testing procedure**
- Remove the spark plug ✓
- Put a new card in the tester ✓
- Turn the ignition on, depress the throttle and crank the engine up to four revolutions ✓
- Activate the tester and move to the next cylinder ✓
- Repeat the process in the other cylinders ✓
- Remove the card and compare with specifications ✓ (6)

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QUESTION 6: ENGINES (SPECIFIC)

6.1 **Function of a crankshaft**
To convert the reciprocating motion of the piston ✓ into a rotary motion to the transmission system. ✓ (2)

6.2 **Causes of vibrations in crankshaft**
- Action of unbalance forces upon the crankshaft ✓
- Torsional effect of the power stroke on the crankshaft ✓ (2)

6.3 **Types of balancing done on crankshaft**
- Static balancing ✓
- Dynamic balancing ✓ (2)

6.4 **Functions of balance mass pieces**
- It is used to balance the mass of piston, connecting rod, web and crank journal ✓
- It is used to provide an opposing centrifugal force to that of the piston, connecting rod, web and crank journal ✓
- It used to counteract the initial loads of the moving parts during acceleration and retardation processes ✓ (3)

6.5 6.5.1 **Connecting rod and piston**
They are kept as light as possible ✓ to reduce reciprocating mass and force ✓ (2)

6.5.2 **Flywheel**
They are carefully balanced and fitted to the crankshaft flange ✓ in one position only ✓ (2)

6.5.3 **Vibration damper**
They are fitted to the front end of the crankshaft ✓ to smoothen out engine vibrations ✓ (2)

6.6 **Vibration damper parts labeling**
A – Crankshaft ✓
B – Crankshaft flange ✓
C – Secondary flywheel ✓
D – Friction disc ✓
E – Friction spring ✓
F – Spring plate ✓ (6)

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

6.8 **Procedure to determine firing order if no specifications available**
- Remove the tapper cover and determine the intake and exhaust valves. ✓
- Rotate the engine in the direction in which it turns ✓
- Watch the direction in which the valves operate ✓
- This will give the order in which the inlet and exhaust stroke occurs ✓
- The power stroke occurs in the same order ✓ (5)

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QUESTION 7: FORCES (SPECIFIC)

7.1 **Swept volume**

It is the volume displaced by the piston ✓ as it moves from bottom dead centre (BDC) to the top dead centre (TDC). ✓ (2)

7.2 **Methods of increasing compression ratio**

- Remove shims from between crankcase and cylinder block ✓
- Fit thinner gasket between cylinder block and cylinder head ✓
- Machine metal from cylinder head ✓
- Skim metal from cylinder block ✓
- Fit piston with suitable higher crowns ✓
- Fit crankshaft with longer stroke ✓
- Increase cylinder bore ✓ (Any 2 x 1) (2)

7.3 7.3.1 **Swept volume**

Bore = 86 mm = 8,6 cm
Stroke = 98 mm = 9,8 cm

$$SV = \frac{D^2}{4} \times L \checkmark$$

$$= \frac{\pi \times 8{,}6^2}{4} \times 9{,}8 \checkmark$$

$$SV = 569{,}26 \text{ cm}^3 \checkmark$$ (3)

7.3.2 **Clearance volume**

$$\text{Compression ratio} = \frac{SV + CV}{CV} \checkmark$$

$$10 = \frac{569{,}26 + CV}{CV} \checkmark$$

$$CV = 63{,}25 \text{ cm}^3 \checkmark$$ (3)

7.3.3 **New bore diameter**

$$\text{Compression ratio} = \frac{SV + CV}{CV} \checkmark$$

$$10{,}8 = \frac{SV + 63{,}25}{63{,}25} \checkmark$$

$$SV = 619{,}85 \text{ cm}^3 \checkmark$$

But

$$SV = \frac{D^2}{4} \times L \checkmark$$

$$619{,}85 = \frac{D^2}{4} \times 9{,}8 \checkmark$$

$$D = 8{,}94 \text{ cm}$$

$$= 89{,}4 \text{ mm} \checkmark$$ (6)

7.4 **Torque**

It is the twisting effort transmitted ✓ by a rotating shaft or wheel ✓

OR

A turning force applied ✓ over the centre of a circular object. ✓ (2)

7.5 7.5.1 **Indicated power**

P = PLANn ✓
P = 1 400 kPa = 1 400 000 Pa ✓
L = 92 mm = 0,092 m
D = 84 mm = 0,084 m

$A = \frac{\pi \times 0.084^2}{4}$ ✓
$= 5.54 \times 10^{-3}\ m^2$ ✓

$N = \frac{3\ 600}{60 \times 2}$
= 30r/s ✓
N = 4 cylinders

Indicated power = 1 400 000 × 0,092 × 5,54 × 10^{-3} × 30 × 4 ✓
= 83 462.40 W
= 83.5 kW ✓ (6)

7.5.2 **Torque**

T= f × r
But f= mg = 30 × 10
= 300 N ✓

T= 300×0.65 ✓
= 195 Nm ✓ (3)

7.5.3 **Brake power**

BP = 2πNT ✓
= 2 × π × 60 × 195 ✓
= 7 3513,27 W
= 73,5 kW ✓ (3)

7.5.4 **Mechanical efficiency**

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

$= \frac{73,5}{83,5} \times 100\%$ ✓

= 88,02% ✓ (2)

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QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Exhaust gases**

- Hydrocarbon ✓
- Carbon monoxide ✓
- Carbon dioxide ✓
- Nitrogen oxide ✓
- Sulphur dioxide ✓
- Oxygen ✓ (Any 4 x 1) (4)

8.2 8.2.1 **Hissing sound from inlet manifold**

- Leaking inlet valves. ✓
- Replace the inlet valves ✓ (2)

8.2.2 **Hissing sound from exhaust manifold**

- Leaking exhaust valves ✓
- Replace the exhaust valves ✓ (2)

8.2.3 **Bubbles in radiator water**

- Blown cylinder head gasket or cracked cylinder block. ✓
- Skim the cylinder head and replace the gasket or replace the block ✓ (2)

8.3 **Low oil pressure reading (possible causes)**

- Worn oil pump ✓
- Blocked pick-up screen in the oil sump ✓
- Warn main big-end and camshaft bearings ✓
- Blocked oil filter ✓
- Dirty or contaminated oil ✓
- Oil leaks ✓
- Too little oil in the engine ✓
- Incorrect oil viscosity ✓
- Defective oil pressure relief valve ✓ (Any 3 x 1) (3)

8.4 **Oil pressure test manufactural specifications**

- Oil pressure when engine is idling ✓
- Oil pressure when engine is cold ✓
- Oil pressure when engine is hot ✓
- Oil pressure on high revolutions ✓ (Any 3 x 1) (3)

8.5 **Reason for conducting pressure test in cooling system**

- To check for possible leakage in the cooling system ✓ (1)

8.6 **Possible engine cooling system components to find leakage**

- Hosepipe ✓
- Water pump ✓
- Radiator ✓
- Core plugs ✓
- Interior heater radiator ✓
- Heater caps ✓ (Any 2 x 1) (2)

8.7 **Functions of a radiator cap**

- Regulates the pressure in the cooling system ✓
- Allows coolant to return to the radiator ✓
- It seals the cooling system to ensure a closed system ✓ (Any 2 x 1) (2)

8.8 **Possible causes of engine overheat**

- Leakage along the line resulting to air trapped in the cooling system ✓
- Cooling fan failure ✓
- Thermostat ✓
- Insulated radiator (poor cooling efficiency) ✓
- Water pump failure ✓
- Bad top gasket ✓ (Any 2 x 1) (2)

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

9.1 **Advantages of using an automatic gearbox**

- It reduces driving fatigue ✓
- A vehicle can stop suddenly without the engine stalling ✓
- The system dampens all engine vibrations ✓
- It ensure great reduction of wheel spin ✓ (Any 3 x 1) (3)

9.2 **Function of a torque converter**

To gradually engage the engine torque with the transmission system ✓ and to multiply the torque automatically according to road and engine speed ✓ (2)

9.3 **Principle of operations of lockup torque converters when lockup clutch is applied**

- The activation and deactivation of the lockup clutch is done by oil pressure ✓
- When the turbine and impeller are up to speed, the fluid is channeled to the clutch piston ✓
- The pressure is guided to the backside of the friction plate where it will press against the impeller, thereby connecting the turbine ✓
- The impeller and the turbine begin to run as one body ✓
- The system improves efficiency and prevents slippage ✓ (5)

9.4 **Advantages of using torque converters**

- Torque increases automatically ✓
- Shocks to gearbox, chassis and wheels are reduced ✓
- Minimum servicing is required ✓ (Any 2 x 1) (2)

9.5 **Transmission control unit (TCU)**

It is a device that controls modern electronic automatic transmissions. It uses vehicle sensors and data from electronic control unit ✓ to calculate how and when to change gears in the vehicle ✓ for optimum performance and fuel economy ✓ (3)

9.6 **Cause of transmission fluid heating up**
- Fluid friction in the torque converter ✓ (1)

9.7 **Methods of cooling oil in automatic transmission**
- By placing special oil cooler alongside the engine cooling radiator ✓
- By using the bottom of engine cooling radiator tank ✓ (2)

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

10.1 **Camber**
It is the tilting inward or outward of a vehicle wheel from its vertical position ✓ in order to meetup with the design specifications of the vehicle model ✓ (2)

10.2 **Disadvantages of camber**
- Reduces lifespan of tyres ✓
- Uneven contact with road ✓
- You will not know when your tyre is due for replacement (negative camber). ✓ (3)

10.3 **Identification of diagrams**
A – Positive Camber ✓
B – Negative Camber ✓ (2)

10.4 **Advantages of positive camber**
- Effective grip on a cambered road surface ✓
- Easier steering ✓

Advantages of negative camber
- It prevents a car from rolling outward from a traffic circle ✓
- It reduces road contact (less wear seen from outside) ✓ (4)

10.5 **Purpose of kingpin inclination in a car front wheels**
- To bring the car front wheels back to the straight-ahead position ✓ after rounding a corner without any driver effort ✓ (2)

10.6 **Kingpin inclination labelling**
A – Offset ✓
B – 90˚ ✓
C – Wheel centre line ✓
D – Kingpin inclination angle ✓
E – Steering axis centre line/kingpin centre line ✓ (5)

10.7 **Factors to be considered before attempting wheel alignment adjustment**

- Kerb mass ✓
- Uneven wear on tyres ✓
- Tyre pressure ✓
- Run-out on the wheels ✓
- Correct pre-load on the wheel bearing ✓
- Kingpins and bushes ✓
- Suspension ball joints for wears ✓
- Suspension bushes for excessive free movement ✓
- Steering box play ✓
- Tie-rod ends ✓
- Sagged springs ✓
- Shock absorber ✓
- Spring U-bolts ✓
- Chassis for possible cracks and loose cross members ✓ (Any 5 x 1) (5)

10.8 **Car wheel alignment identification**

- Toe-out ✓ (1)

10.9 **Purpose of toe-out in a car suspension system**

- To give a true rolling motion ✓ on the front wheels in a corner without scuffing. ✓ (2)

10.10 10.10.1 **Static balance**

It is the equal distribution of all weight ✓ around the axis of rotation in a single plane of rotation. ✓ (2)

10.10.2 **Dynamic balancing**

It is the equal distribution of all weight ✓ around the axis of rotation in all rotational planes. ✓ (2)

10.11 **Pre-checks on a wheel before balancing**

- Check the tyres for bruises, cracks and damaged side walls ✓
- Check the rim for any damages ✓
- Check for any foreign matter on the rim and tyre ✓ (Any 2 x 1) (2)

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TOTAL: 200