basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

MECHANICAL TECHNOLOGY

EXEMPLAR 2017

MEMORANDUM

MARKS: 200

This memorandum consists of 28 pages.

SECTION A (GENERIC)

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

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QUESTION 2: SAFETY (GENERIC)

2.1 **Angle grinder:**

- The safety guard must be in place before starting. ✓
- Protective shields must be placed around the object being grinded to protect the people around. ✓
- Use the correct grinding disc for the job. ✓
- Make sure that there are no cracks on the disc before you start. ✓
- Protective clothing and eye protection are essential. ✓ ANY 3 x 1 (3)

2.2 **Welding helmet:**

- To protect your face against sparks ✓
- To protect your face against UV-rays ✓
- To protect your eyes against UV-rays ✓
- To protect your face against heat ✓ ANY 3 x 1 (3)

2.3 **Portable drill machine:**

- Do not leave the chuck key in the chuck. ✓
- Clamp the work piece securely to the table, do not hold by hand. ✓
- Clamp the drill bit securely in the chuck. ✓
- Never try to stop the work piece by hand if it slips from the clamp.✓
- Never try to stop the chuck by hand. ✓
- Do not force drilling. ✓
- Use the correct speed and bit for the job. ✓
- Do not use loose clothing. ✓
- Always wear goggles to protect your eyes ✓ ANY 3 x 1 (3)

2.4 Ensure that you switch it off. ✓ (1)

2.5 **Horizontal band saw:**

- See that all safety guards are in place ✓
- See that there is no grease, oil and obstacles around the machine ✓
- See that the correct blade for the job is installed ✓
- Make sure that work piece is properly clamped ✓
- See that the blade speed is set correctly ✓ ANY 3 x 1 (3)

2.6 Clamp the small work piece securely and firmly so it does not slip while drilling. ✓ (1)

2.7 **Hydraulic press:**

- The predetermined pressure of the hydraulic press must not be exceeded. ✓
- Ensure the pressure gauge is in a good working order. ✓
- Platform in which the work piece rest must be rigid and square with the cylinder of the press. ✓
- Prescribed equipment must be used.✓
- Check that securing pins for the platform are fitted properly. ✓
- Check hydraulic pipes for leaks ✓
- Check for oil on the floor. ✓ ANY 3 x 1 (3)

2.8 **Gas welding equipment:**
- Safety goggles with dark lenses ✓
- Leather apron ✓
- Safety boots ✓
- Use leather gloves ✓
- Overall ✓ ANY 3 x 1 (3)

2.9 **Flint lighter:**
- Cigarette lighter is explosive and ✓
- Match burns continuously without stopping ✓ (2)

2.10 **Surgical gloves:**
- To prevent infection ✓
- To prevent the transmission of blood related diseases, like HIV/Aids ✓ (2)

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QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)

3.1 **Cutting Machine:**

3.1.1 Drill press ✓ (1)

3.1.2 A. Base ✓
B. Column ✓
C. Motor ✓
D. Feed lever ✓
E. Chuck ✓
F. Machine table ✓ (6)

3.1.3 To hold the drill bit ✓ (1)

3.2 **Tap and die set:**
- Tap to cut internal screw threads ✓
- Die to cut external screw threads ✓ (2)

3.3 **Saws:**
- Power saw – blade move forward and backward ✓
- Horizontal band saw – blade moves in a circular motion ✓ (2)

3.4 **Function of equipment:**

3.4.1 Rolling machine – used to roll sheet metal ✓✓ (2)

3.4.2 Press machine – press fit or remove parts from each other ✓✓ (2)

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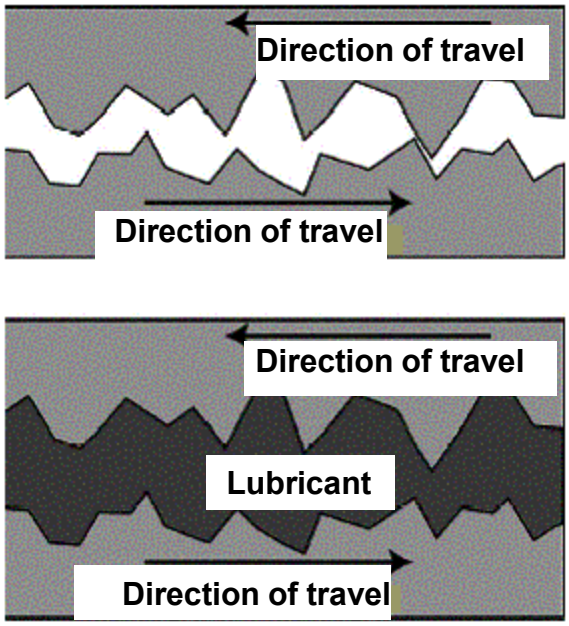
QUESTION 4: MAINTENANCE (GENERIC)

4.1 **Effect of a lubricant between two surfaces in contact:**



(2)

4.2 **Lack of lubrication in a gear system:**

- Without lubrication friction between teeth contact surfaces becomes too great, resulting in loss of efficiency ✓
- Excessive noise ✓
- Overheating ✓
- Eventual mechanical failure ✓ ANY 2 X 1 (2)

4.3 Friction is a force that resists ✓✓ the movement of one object over another. ✓ (2)

4.4 Overloading is when the lubrication bearer of oil is effectively squeezed out of the machines bearing surfaces. ✓✓ (2)

[8]

QUESTION 5: MATERIALS (GENERIC)

5.1 **Properties of engineering materials:**

5.1.1 **Hardness:** Ability to withstand ✓ surface indentation ✓ and scratching ✓ (3)

5.1.2 **Elasticity:** Ability of a body to resist a distorting influence or stress ✓ and to return to its original size and shape ✓ when the stress is removed.✓ (3)

5.1.3 **Malleability:** Ability to deform permanently ✓ under compressive forces ✓ or hammering ✓ without developing defects. (3)

5.1.4 **Toughness:** Ability of a material to absorb ✓ shock loads. ✓✓ (3)

5.2 Pig iron ✓ (1)

5.3 **Function of the following elements used in a blast furnace:**

5.3.1 **Iron ore:** Raw material for producing iron ✓✓ (2)

5.3.2 **Coke:** Acts as a fuel to provide heat for smelting ✓✓ (2)

5.3.3 **Limestone or dolomite:** Serves as a fluxing agent and binds with impurities ✓✓ (2)

5.4 **Blast furnace labels:**

A. Iron tap hole ✓
B. Hot air supply from stoves ✓
C. Steel casing ✓
D. Refractory brick lining ✓
E. Hopper or Load ✓
F. Small bell ✓
G. Larger bell ✓
H. Stack ✓
I. Melting zone ✓
J. Slag tap hole ✓ (10)

5.5 **Function of electric arc furnace:**
The furnace heats ✓ charged metal ✓ by means of an electric arc. ✓ (3)
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TOTAL SECTION A: 100

SECTION B: FITTING AND MACHINING (SPECIFIC)

QUESTION 6: TERMINOLOGY (SPECIFIC)

6.1 **Centre lathe functions:**

6.1.1 **Four-jaw chuck:** To clamp an awkwardly-shaped ✓ object in a centre lathe. ✓ (2)

6.1.2 **Lathe steadies:** To support long or slender shafts ✓ in one or more places, in a centre lathe. ✓ (2)

6.1.3 **Lathe mandrels:** It is used for the further machining ✓ of a work piece between centres after it has been bored or reamed ✓ while held in the chuck. (2)

6.2 $Compound\ slide\ angle\ tan\frac{\theta}{2} = \frac{D-d}{2l}$ ✓

$$tan\frac{\theta}{2} = \frac{78-62}{2(105)}$$ ✓

$$\frac{\theta}{2} = 4{,}36°$$ ✓ (3)

6.3 **Screw threads:**

6.3.1 **The helix angle of the thread:**

Lead = number of starts × pitch ✓
Lead = 3 × 7
Lead = 21 mm ✓
Helix angle: $tan\theta = \frac{lead}{\pi\ diameter}$ ✓

Helix angle: $tan\theta = \frac{21}{\pi\ diameter}$

$$\tan\theta = \frac{21}{\pi 90}$$

θ *= 4,25°* ✓ (4)

6.3.2 **The leading tool angle:**
Leading tool angle = 90° – (clearance angle + helix angle) ✓
Leading tool angle = 90° – (3° + 4,25°)
Leading tool angle = 82,75° ✓ (2)

6.3.3 **The following tool angle:**
Following tool angle = 90° + (helix angle – clearance angle) ✓
Following tool angle = 90° + (4,25° – 3°)
Following tool angle = 91,25° ✓ (2)

6.4 **Parallel key:**

6.4.1 **The width:**

$$Width\ of\ key = \frac{Diameter\ of\ shaft}{4}\ \checkmark$$
$$= \frac{60}{4}$$
$$= 15\ \text{mm}\ \checkmark$$ (2)

6.4.2 **The thickness:**

$$Thickness\ of\ key = \frac{Diameter\ of\ shaft}{6}\ \checkmark$$
$$= \frac{60}{6}$$
$$= 10\ \text{mm}\ \checkmark$$ (2)

6.4.3 **The length:**

$$Length\ of\ key = 1{,}5\ \times diameter\ of\ shaft\ \checkmark$$
$$= 1{,}5\ \times 60$$
$$= 90\ \text{mm}\ \checkmark$$ (2)

6.5 **Milling cutters:**

6.5.1 Side and face mill ✓ (1)

6.5.2 T-slot mill ✓ (1)

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QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1 **Purpose of tools:**

7.1.1 **Dial indicator:** It is used as precision-measuring tool in setting up of work on machinery, such as centre lathes or milling machines. ✓ (1)

7.1.2 **Telescopic gauge:** To provide a quick and accurate method of checking inside measurements. ✓ (1)

7.2 **Reasons for using a torque wrench:** (3)

- It prevents bolts or studs from breaking. ✓
- It prevents bolts and nuts from loosening. ✓
- It prevents castings from warping. ✓

7.3 ✓ ✓ ✓
170,11 mm (3)

[8]

QUESTION 8: FORCES (SPECIFIC)

8.1 **Moments:**

Calculate A. Take moments about B.

$\sum LHM = \sum RHM$

$(A \times 3{,}2) + (300 \times 1{,}2) = (800 \times 2{,}4)$ ✓

$\frac{3{,}2A}{3{,}2} = \frac{1\,920 - 360}{3{,}2}$

$A = 487{,}5\ N$ ✓

Calculate B. Take moments about A.

$\sum RHM = \sum LHM$

$(B \times 3{,}2) + (800 \times 0{,}8) = (300 \times 4{,}4)$ ✓

$\frac{3{,}2B}{3{,}2} = \frac{640 - 1320}{3{,}2}$

$B = 612{,}5\ N$ ✓ (4)

8.2 **Stress:**

$A = \frac{\pi(D^2 - d^2)}{4}$ ✓

$= \frac{\pi(0{,}06^2 - 0{,}054)}{4}$

$= 0{,}54 \times 10^{-3} m^2$ ✓

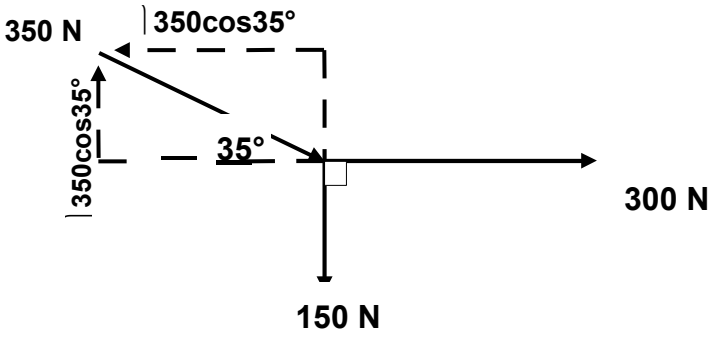
$\sigma = \frac{F}{A}$ ✓

$= \frac{60 \times 10^3}{0{,}54 \times 10^{-3}}$ ✓

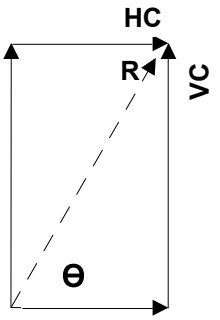
$= 111{,}11 \times 10^6\ Pa$

$= 111{,}11\ MPa$ ✓ (5)

8.3 **Forces:**



$$HC = 300 - 350\cos 35° \quad \checkmark$$
$$= 300 - 286,70$$
$$= 13,3\,N \quad \checkmark$$



$$VC = 350\sin 35° - 150 \quad \checkmark$$
$$= 200,75 - 150$$
$$= 50,75\,N \quad \checkmark$$

$$R^2 = HC^2 + VC^2$$
$$\sqrt{R^2} = \sqrt{13,3^2 + 50,75^2}$$
$$R = 52,46\,N \quad \checkmark$$

$$Tan\,\theta = \frac{VC}{HC}$$
$$= \frac{50,75}{13,3}$$
$$\theta = 75,31° \quad \checkmark$$

Resultant = 52,46 N 75,31° North from East ✓

(10)
[19]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 **Lathes and milling machines:**

- Lack of lubrication ✓
- Overloading ✓
- Balancing ✓ (3)

9.2 **Overheating:**

If a machine runs over extended periods with inadequate lubrication ✓ the machine will exceed the normal operating temperature ✓ which will cause excessive friction and wear. (2)

9.3 **Physical wear on the milling cutter of a milling machine:**

- Cutting fluid should be applied. ✓
- Do not exceed the appropriate cutting depth. ✓
- Do not exceed the appropriate feed. ✓ ANY 1 x 1 (1)

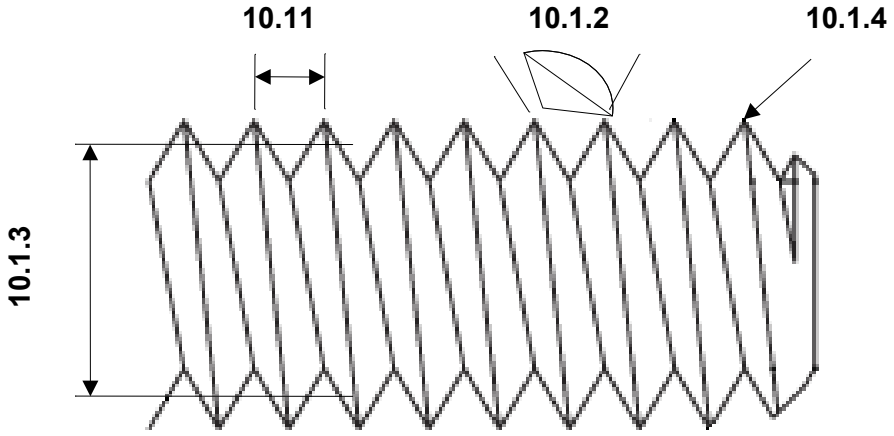
9.4 **Unbalanced work piece in a lathe:**

- Vibration ✓
- Inaccurate results ✓
- Risk of work piece coming loose ✓ ANY 2 x 1 (2)

[8]

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1 **Isometric V-screw thread:**



10.1.1 Pitch ✓ (1)

10.1.2 Screw-thread angle ✓ (1)

10.1.3 Effective diameter ✓ (1)

10.1.4 Crest ✓ (1)

10.2 **Calculations of screw threads:**

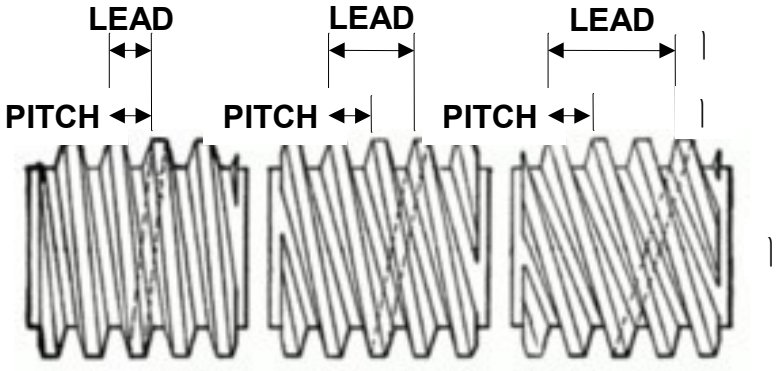
10.2.1 **The depth of the screw thread:**

$H = 0{,}86603\ P$
$= 0{,}86603 \times 2{,}5$✓
$= 2{,}165075\ mm$ ✓ (2)

10.2.2 **The effective diameter of the screw thread:**

$Pitch\ diameter\ of\ thread = OD - 2\left(\frac{3H}{8}\right)$
$= 20 - 2\left(\frac{3 \times 2{,}17}{8}\right)$✓
$= 18{,}38$ mm ✓ (2)

10.3 **Single- and multiple-start screw threads:** (4)



(4)
[12]

QUESTION 11: SYSTEMS AND CONTROL (SPECIFIC)

11.1 **Advantages of a belt drive compared to a gear drive:**

- Power can be transmitted over a longer distance. ✓
- Less noisy. ✓
- Does not need any lubrication. ✓
- Change of direction can be done by twisting the belt, therefore no extra parts are needed. ✓
- Cheaper system. ✓
- Easy to repair. ✓ ANY 3 x 1 (3)

11.2 **Hydraulics:**

$A_{piston} = \frac{\pi d^2}{4}$ ✓
$= \frac{\pi(0{,}12)^2}{4}$ ✓
$= 11{,}31 \times 10^{-3}\ m^2$ ✓

$p = \frac{F}{A}$ ✓
$F = p \times A$
$= (1{,}2 \times 10^6) \times (11{,}31 \times 10^{-3})$
$= 13\,572\ N$
$= 13{,}57\ kN$ ✓ (4)

11.3 **Belt-drive systems:**

11.3.1 **Belt speed:**

$$Belt\ speed = \frac{\pi DN}{60} \checkmark$$
$$= \frac{\pi \times 0{,}23 \times 1440}{60}$$
$$= 17{,}34\ m.s^{-1} \checkmark$$ (2)

11.3.2 **Power transmitted:**

$$Power\ (p) = (T_1 - T_2)v \checkmark$$
$$= 165 \times 17{,}34$$
$$= 2861{,}1\ W$$
$$= 2{,}86\ kW \checkmark$$ (2)

11.4 **Gear drives:**

11.4.1 **Direction of rotation of gear C =** Clockwise ✓ (1)

11.4.2 **Number of teeth on gear C:**

$$T_C N_C = T_A N_A \checkmark$$

$$T_C = \frac{T_A \times N_A}{N_C}$$
$$= \frac{102 \times 120}{80}$$
$$= 153\ teeth \checkmark$$ (2)

11.5 **Gear ratio of the system:**

$$Gear\ ratio = \frac{Product\ of\ the\ number\ of\ teeth\ on\ driver\ gears}{Product\ of\ the\ number\ of\ teeth\ on\ the\ driven\ gears} \checkmark$$
$$= \frac{54}{18}$$
$$= 1:3 \checkmark$$ (2)
[16]

QUESTION 12: PUMPS (SPECIFIC)

12.1 **Monopump:**

- Food and drink pump ✓
- Oil pumping ✓
- Slurry pumping ✓
- Sewage sludge pumping ✓
- Viscous chemical pumping ✓ ANY 2 x 1 (2)

12.2 **Advantages of centrifugal pumps:**

- More compact less floor space. ✓
- Initial cost is relatively low. ✓
- Maintenance costs are low due to rotating motion of the main parts. ✓
- Are quite adaptable. ✓
- Construction of the pump is simple and reliable. ✓
- Works at high speeds can be connected directly to a motor. ✓
- Water hammer and shocks do not occur because the pump delivers a regular and continuous stream of fluid. ✓
- Have no moving valves or sensitive parts. The delivery of fluid can be regulated from no flow to full flow without switching off or damaging the pump. ✓ ANY 2 x 1 (2)

12.3 **Reciprocating pump:**

- An inlet valve also called admission pump ✓
- An outlet valve also called a discharge valve ✓
- A pump or piston ✓ ANY 3 x 1 (3)

12.4 **Disadvantages of gear pumps:**

- Wear between the gears and the housing reduces the pump pressure. ✓
- When the gears wear the pump tends to be noisy. ✓ ANY 2 x 1 (2)

12.5 **Impellers:**

12.5.1 Open-vane impeller ✓ (1)

12.5.2 Semi-open or ribbed impeller ✓ (1)

12.5.3 Enclosed or shrouded impeller ✓ (1)

[12]

TOTAL SECTION B: 100

SECTION C: AUTOMOTIVE (SPECIFIC)

QUESTION 13: TOOLS AND EQUIPMENT (SPECIFIC)

13.1 **Outside micrometer:**

A. Anvil ✓
B. Spindle ✓
C. Barrel ✓
D. Thimble ✓ (4)

13.2 **Torque wrench:**

- It prevents bolts or studs from breaking. ✓
- It prevents bolts or studs from loosening. ✓
- It prevents castings from warping. ✓ ANY 2 x 1 (2)

13.3 **Dial gauge indicator:**

- To determine the run-out of a flywheel. ✓
- To determine if a crankshaft is bent. ✓
- To determine if a work-piece in a lathe is running true. ✓
- To determine if two work pieces are the same size. ✓ ANY 2 x 1 (2)

13.4 **Telescopic gauge:**

It provides a quick and accurate means of checking inside measurements.✓ (1)

[9]

QUESTION 14: ENGINES (SPECIFIC)

14.1 **Direct ignition:**

The injector injects the fuel directly into the combustion chamber which has a cavity in the crown of the piston. ✓ (1)

14.2 **Injector:**

To deliver fuel in a fine spray into the charge. ✓ (1)

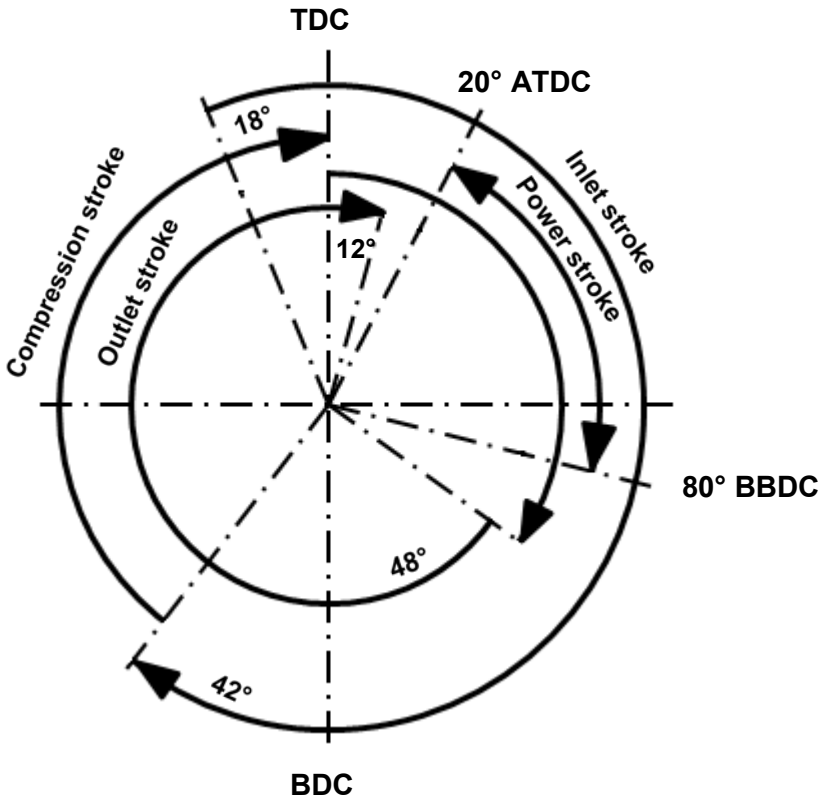
14.3 **Injector nozzles:**

- Multi hole ✓
- Single hole ✓
- Pintle type ✓ ANY 2 x 1 (2)

14.4 **Hydraulic valve lifters:**

- Operates silently. ✓
- No clearance between rocker and valve stem. ✓
- Precise timing for the opening and closing of the valves.✓ (2)

14.5 **Valve-timing diagram:**



14.5.1 **Inlet-valve period:**
= 18° + 180° + 42°
= 240° ✓ (1)

14.5.2 **Exhaust-valve period:**
= 180° + 48° + 12°
= 240° ✓ (1)

14.5.3 **Power period:**
= 180° - 48°
= 132° ✓ (1)

14.5.4 **Valve overlap:**
= 18° + 12°
= 30° ✓ (1)

14.6 **Tensioner:**
- To ensure the correct tension in the timing belt ✓
- To prevent belt slip ✓
- To prevent it from knocking noisily against the timing cover ✓

ANY 1 x 1 (1)
[15]

QUESTION 15: SYSTEMS AND CONTROL (SPECIFIC)

15.1 Semi-floating axle ✓ (1)

15.2 To allow a high voltage to jump across the gap between the electrodes to ignite the compressed air/fuel mixture. ✓✓ (2)

15.3 15.3.1 Spiral final drive ✓ (1)

15.3.2 Hypoid final drive ✓ (1)

15.4 **Hydraulic brake master cylinder:**
A. Rebound spring ✓
B. Control valve ✓
C. Reservoir ✓
D. Plunger ✓
E. Push rod ✓ (5)

15.5 Brake servo unit enhances ✓ the braking action. ✓ (2)

15.6 Anti-lock braking system ✓ (1)

15.7 **Anti-lock braking system:**
A. Electric controller ✓
B. Apportioning valve (pressure valve) ✓
C. Brake cylinder ✓
D. Modulator ✓ (4)

15.8 Independent suspension ✓ (1)

15.9 **Suspension systems:**

15.9.1 Anti-sway bar ✓ (1)

15.9.2 Stabiliser bar ✓ (1)

15.10 **Functions of control systems:**

15.10.1 **Traction control:** Prevent the wheels from spinning ✓ if the torque transmitted to any wheel rises above that which can be transmitted by the tyre. ✓ (2)

15.10.2 **Air bag control:** Activates the air bags ✓ in the event of a collision. ✓ (2)

15.11 **Drive system:**

15.11.1 Four wheel drive ✓ (1)

15.11.2 A. Rear wheel final drive ✓
B. Transfer gearbox ✓
C. Gearbox ✓
D. Front wheel final drive ✓ (4)

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QUESTION 16: MAINTENANCE (SPECIFIC)

16.1 **Function of an oil pump:**
To draw the oil from the sump ✓✓ and force it under pressure to the different engine components. ✓ (2)

16.2 **Oil loss:**
- Check for exhaust smoke. ✓
- Check for oil leaks. ✓
- Check for oil vapour from the ventilation tube. ✓ (3)

16.3 **Oil filtration systems:**
- By-pass system ✓
- Full-flow filter ✓ (2)

16.4 **Function of oil seals:**
- Prevents oil leaks. ✓
- Prevents water and dust from entering the component. ✓ ANY 1 x 1 (1)

16.5 **Gear pump operation:**
- Small pockets of oil are trapped between the gear teeth and the pump housing. ✓
- The rotating spaces between the teeth carry the oil towards the outlet port, at the same time a vacuum is created over the inlet port and oil is drawn from the sump. ✓
- Oil cannot return between the gear teeth and pressure is built up, causing the oil to be forced out through the outlet port from where it is fed to the oil channels. ✓ (3)

[11]

QUESTION 17: FORCES (SPECIFIC)

17.1 **Indicated power:**

Indicated Power = PLANn
Where:
P = Indicated Power
L = Length of stroke in metres
A = Area of piston crown m^2
N = Number of power strokes per second (4 strokes divided by 2)
n = Number of cylinders

$p = 900 \times 10^3\ Pa$
$L = 80 \times 10^{-3}\ m$
$A = \frac{\pi D^2}{4}$ ✓
$= \frac{\pi 0{,}09^2}{4}$
$= 6{,}36 \times 10^{-3}\ m^2$ ✓

$N = \frac{3600}{60 \times 2}\ power\ strokes\ per\ second\ \ (four\ strokes)$ ✓
$= 30\ power\ strokes$ ✓
$n = 4\ cylinders$

$Indicated\ Power = pLANn$ ✓
$= \left(900 \times 10^{3)}\right) \times (80 \times 10^{-3}) \times (6{,}36 \times 10^{-3}) \times 30 \times 4$
$= 54950{,}04\ watts$ ✓
$= 54{,}95\ kW$ ✓✓ (8)

17.2 **Automotive terms:**

17.2.1 **1 joule work done:**
When the point ✓ at which a force of 1 Newton ✓ is applied, moves ✓ a distance of 1 metre ✓ in the direction of the force. (4)

17.2.2 **Power:**
It is the rate ✓ at which work ✓ is done within a unit of time. ✓ (3)

17.2.3 **Torque:**
It is the moment ✓ caused by a force acting around a point ✓ at a distance from that point. ✓ (3)

17.2.4 **Compression ratio:**
It is the ratio ✓ of the compression ✓ of the inlet charge during the compression stroke ✓ in the combustion chamber to the total volume in the cylinder. ✓ (4)

17.2.5 **Indicated power:**
It is the theoretical or calculated power ✓ that the engine should generate without ✓ considering any mechanical or other losses. ✓ (3)

17.3 **Compression ratio:**

$Compression\ ratio = \frac{Swept\ volume + Clearance\ volume}{Clearance\ volume}$ **OR** ✓

$Compression\ ratio = \frac{Swept\ volume}{Clearance\ volume} + 1:1$

NOTE: Convert mm to cm.

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

$= \frac{\pi \times 8}{4} \times 9\ cc\ OR\ cm^3$

$= 542{,}39\ cc$ ✓

$Compression\ ration = \frac{SV}{CV} + 1:1$ ✓

$= \frac{452{,}39}{50} + 1:1$

$= 9{,}05 + 1:1$

$= 10{,}05:1$ ✓ (5)

[30]

QUESTION 18: TERMINOLOGY (SPECIFIC)

18.1 **Job card:**

1. Change engine oil ✓
2. Change oil filter ✓
3. Wash engine ✓
4. Oil ✓ (4)

18.2 **Manufacturer's specification manual:**

- Detailed information explaining the repair of the motor vehicle. ✓
- Step by step procedures, specifications, diagrams, illustrations and other data for each make and model of vehicles. ✓ ANY 1 x 1 (1)

18.3 Work according to the manufacturer's specifications:
It ensures correct maintenance practices. ✓ (1)

[6]

TOTAL SECTION C: 100

SECTION D: WELDING AND METALWORK (SPECIFIC)

QUESTION 19: WELDING TERMINOLOGY (SPECIFIC)

19.1 **Uses of templates:**

- Templates are used to avoid repetitive marking off of the same dimensions ✓
- To avoid unnecessary wastage of material ✓ (2)

19.2 **Welding symbols:**

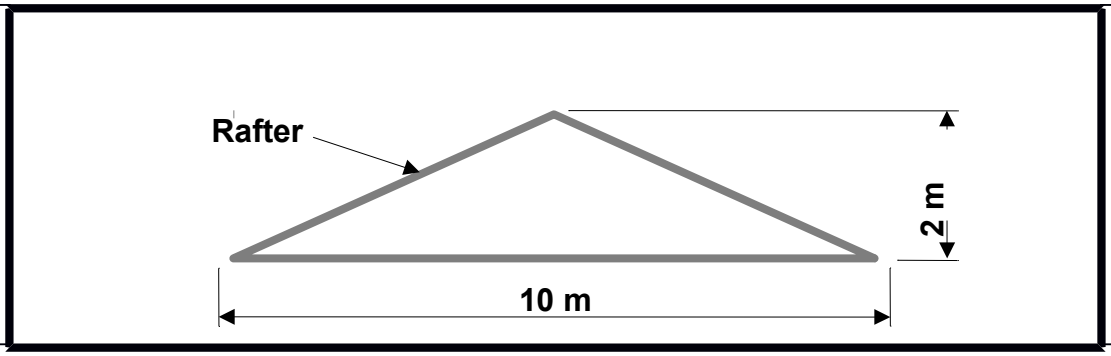
19.2.1 Convex finish ✓ (1)

19.2.2 Machining ✓ (1)

19.3 **Part of roof truss:**

A. Tie beam ✓
B. Rafter ✓
C. Ridge ✓
D. Rise ✓
E. Span ✓ (5)

19.4 **Rafter calculations:**



$Rafter^2 = (Span \div 2)^2 + Rise^2$ ✓
$= (10 \div 2)^2 + 2^2$ ✓
$= 25 + 4$ ✓
$Rafter^2 = 29$ ✓
$Rafter = \sqrt{29}$
$= 5{,}39\ m$ ✓ (5)

19.5 **Multiple-run butt joint:**

A. Parent metal ✓
B. Heat affected zone ✓
C. Weld face ✓
D. Weld run✓ (4)

[18]

QUESTION 20: TOOLS AND EQUIPMENT (SPECIFIC)

20.1 **Working principle of the cropper on a punch and shearing machine:**
Shearing off bars and sections by means of a sliding blade ✓ behind a fixed blade ✓ with the shape of the profile in it. ✓ (3)

20.2 **Use of the punching machine:**
To rapidly remove metal to a form of round, square or other shaped holes ✓ by using a top punch and a bottom die. ✓ (2)

20.3 **Functions of machines:**

20.3.1 **Guillotine:**
The guillotine is generally used to cut sheet metal ✓ (1)

20.3.2 **Rolling machine/Bending roll:**
A rolling machine is used to roll (form) flat bar, plate, angle iron, and various other steel profiles. ✓ (1)
[7]

QUESTION 21: FORCES (SPECIFIC)

21.1 **Stress and strain:**

21.1.1 **Stress:**

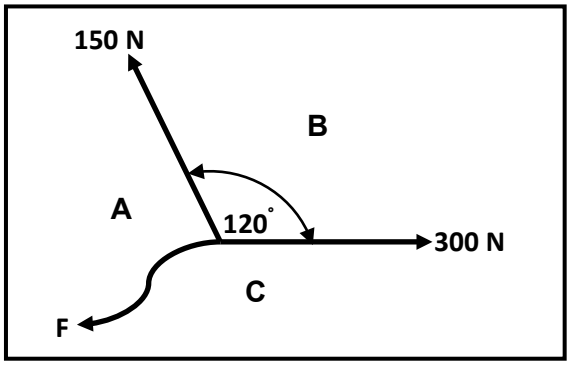
$$A = \frac{\pi(D^2 - d^2)}{4}$$
$$= \frac{\pi(0{,}038^2 - 0{,}034^2)}{4}$$
$$= 0{,}23 \times 10^{-3} 10\, m^2 \ \checkmark$$

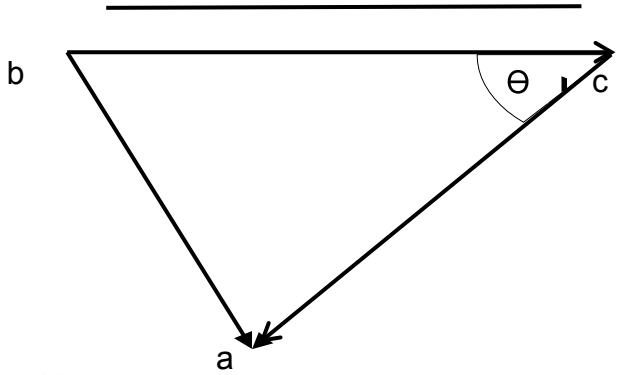
$$\sigma = \frac{F}{A} \quad \checkmark$$
$$= \frac{50 \times 10^3}{0{,}23 \times 10^{-3}}$$
$$= 217{,}39 \times 10^6 Pa$$
$$= 217{,}39\, MPa \ \checkmark$$ (3)

21.1.2 **Strain – E = 90 x 10^3 MPa):**

$$\varepsilon = \frac{\sigma}{E} \ \checkmark$$
$$= \frac{217{,}39 \times 10^6}{90 \times 10^9} \ \checkmark$$
$$= 2{,}42 \times 10^{-3} \ \checkmark$$ (3)

21.2 **Forces:**

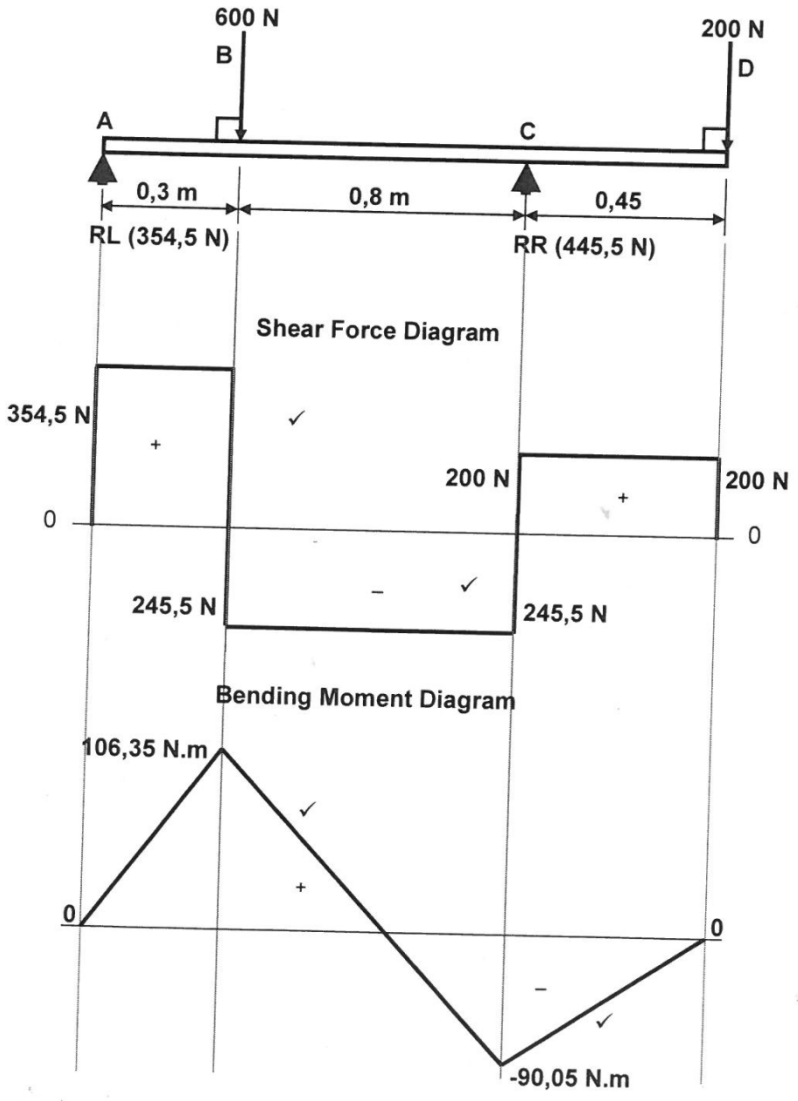




Scale 1 mm =5 N
ac = F = 265 N ✓ θ = 30° South from West ✓ (3)

21.3 **Shear force and bending moment diagrams:**

$BMa = 0\ N.m$ ✓
$BMb = (354{,}5\ \times 0{,}3) = 106{,}35\ N.m$ ✓
$BMc = (354{,}5\ \times 1{,}1) + (-600\ \times 0{,}8) = -90{,}05\ N.m$ ✓
$BMd = (354{,}5\ \times 1{,}55) + (-600\ \times 1{,}25) + (445{,}5\ \times 0{,}45) = 0\ N.m$ ✓


600 N
B
200 N
D
A
C
0,3 m
0,8 m
0,45
RL (354,5 N)
RR (445,5 N)
Shear Force Diagram
354,5 N
+
✓
200 N
+
200 N
0
0
245,5 N
–
✓
245,5 N
Bending Moment Diagram
106,35 N.m
✓
+
0
0
–
✓
-90,05 N.m

(8)

[17

QUESTION 22: MAINTENANCE (SPECIFIC)

22.1 **Malfunctioning of cutting machines:**

- Lack of lubrication or incorrect lubrication ✓
- Overloading ✓
- Friction ✓ ANY 1 x 1 (1)

22.2 **Results of inadequate lubrication:**

- Friction causing excessive wear ✓
- Overheating causing bearings to seize ✓ (2)

22.3 **Prevent excessive wear:**

The specified lubricant is to be applied to the relevant lubricating point in a specified quantity and at specific time. ✓ (1)

22.4 **Factors that effectively extends the machine's service life:**

- Proper operation in accordance with manufacture's instruction. ✓
- Machine should be kept clean at all times. ✓
- Before starting machine, ensure that it is timely and quantificationally lubricated. ✓
- All electrical parts should work in a safe and reliable way. ✓
- A well trained person should operate the machine to prevent breaking or causing accidents. ✓ ANY 2 x 1 (2)

[6]

QUESTION 23: JOINING METHODS (SPECIFIC)

23.1 **Iron carbon equilibrium diagram:**

23.1.1 **Labels:**

A – Ferrite – Perlite ✓
B – Ferrite – Austenite ✓
C – Austenite ✓
D – Cementite – Austenite ✓
E – Perlite – Cementite ✓ (5)

23.1.2 **Properties of perlite – cementite:**

- Hard ✓
- Brittle ✓ (2)

23.2 **Purpose of case hardening:**

To give steel a hard surface ✓ with a tough core ✓ (2)

23.3 **Causes of slag inclusion:**

- Slag not removed from previous weld ✓
- Current is to low ✓
- Arc is too long ✓
- Welding tempo is too fast ✓ ANY 2 x 1 (2)

23.4 **Functions of the flux on a welding electrode:**

- Protecting the steel core ✓
- Cause gas shield to protect weld from atmospheric contamination ✓
- Form slag on top of weld to protect while cooling ✓ ANY 2 x 1 (2)

23.5 **Inert gases for MIG/MAGS welding:**

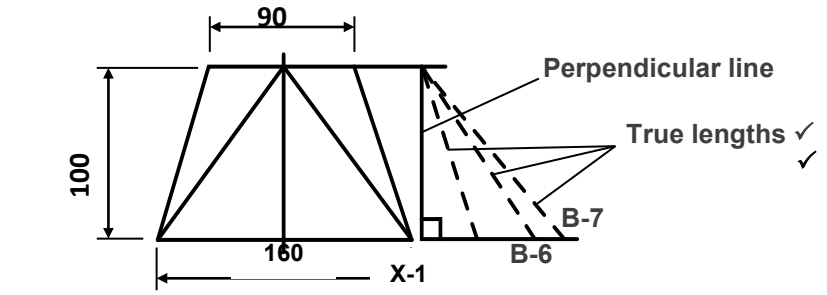
- CO_2 ✓
- Argon ✓
- Helium ✓
- Teral (Argon + CO_2) ✓ ANY 2 x 1 (2)

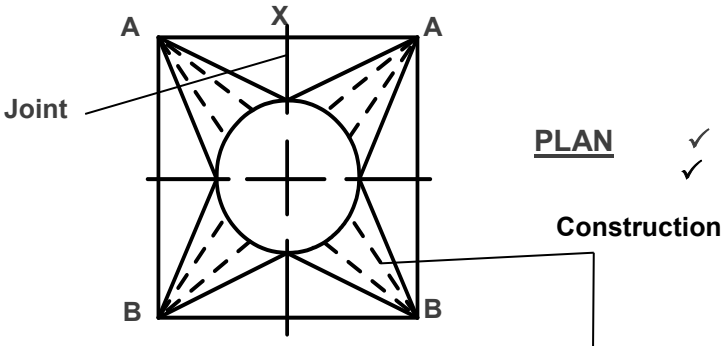
[15]

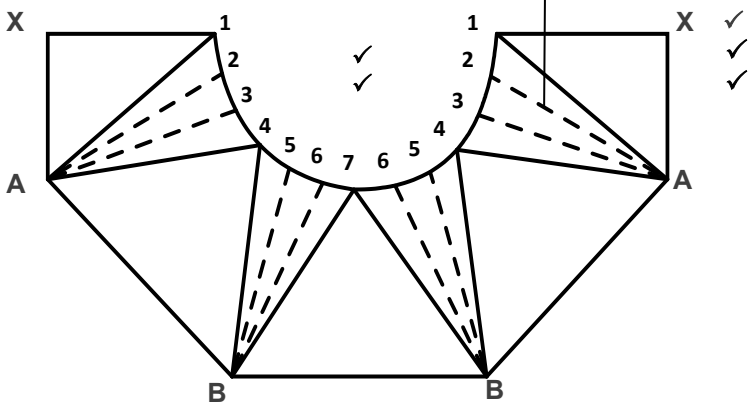
QUESTION 24: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

24.1 **Develop the square to round transition piece:**

FRONT ELEVATION



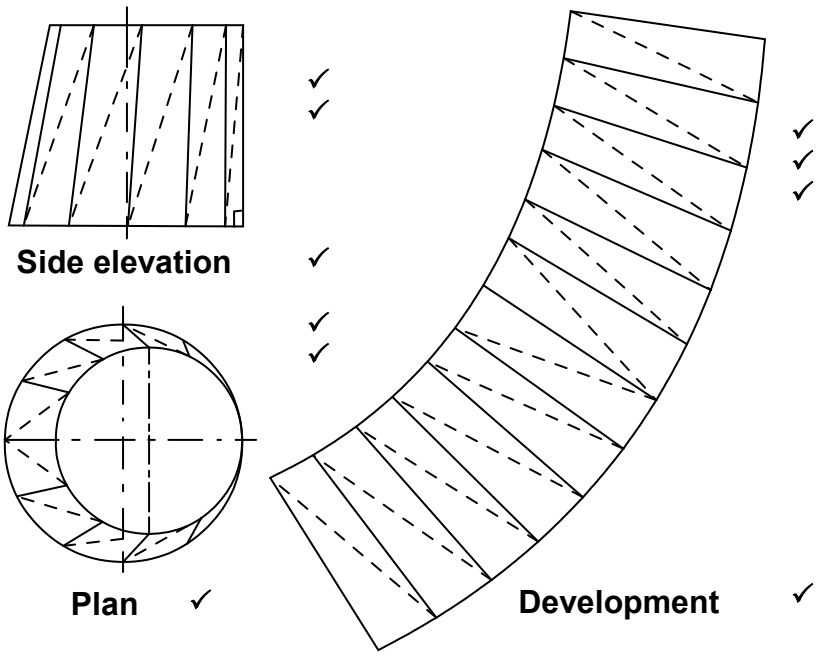




DEVELOPMENT

(9)

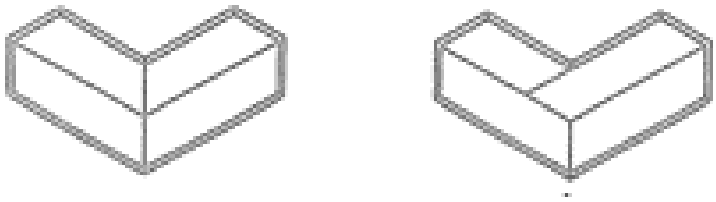
24.2 **Develop the oblique cone:**



(10)
[19]

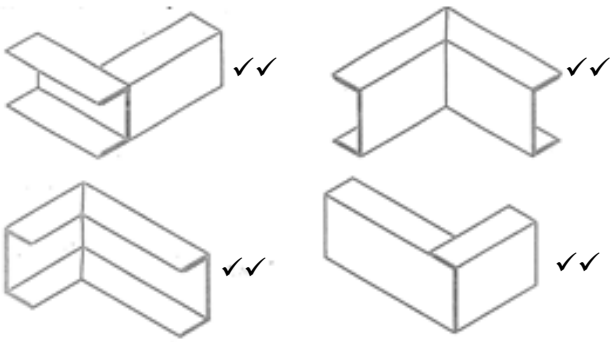
QUESTION 25: TERMINOLOGY (STEEL SECTIONS) (SPECIFIC)

25.1 **Preparation of the ends of two equal angle iron bars:**



(4)

25.2 **Preparation of the ends of two equal-channel iron bars:**



ANY 3 x 2 (6)

25.3 **Purpose of an assembly jig:**
To hold parts in position ✓ so that a number of identical items can be tack welded and easily removed before final welding is done ✓ (2)

25.4 **Advantages of a well-designed jig in a welding shop:**
- Assembled items are identical ✓
- Assembly time is reduced ✓
- Worker can do the work alone ✓
- Saves unnecessary measuring ✓
- Enables untrained workers to do the work ✓
- Jigs can be stored for long periods of time and used again ✓
- Reduces distortion ✓
- Reduces the cost of production ✓ ANY 3 x 1 (3)

25.5 **Requirements of a well-designed welding jig in a welding shop:**
- It must be easily understood ✓
- It must be rigid ✓
- It must be light and easy to handle ✓
- It must be accurate ✓
- It must not be expensive to make ✓
- It must hold the parts to be assembled and allow them to be easily removed from the jig ✓ ANY 3 x 1 (3)

[18]

TOTAL SECTION D: 100
GRAND TOTAL: 200