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EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 12

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MECHANICAL TECHNOLOGY: FITTING AND MACHINING MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

- 1.1 A ✓ (1)
- 1.2 B ✓ (1)
- 1.3 C ✓ (1)
- 1.4 A ✓ (1)
- 1.5 D ✓ (1)
- 1.6 C ✓ (1)
- [6]**

QUESTION 2: SAFETY (GENERIC)**2.1 Recommendations for the application of first aid:**

- It is vital that the person applying first aid remembers his/her limitations and realises that only first aid needs to be applied before the casualty is referred to a medical practitioner. ✓
- If possible, take away the cause of the accident to avoid any further injuries. ✓
- Attention must be given instantly to loss of blood and breathing difficulties. ✓
- The pulse must be checked and the pulse rate counted.
- Determine the state of shock and treat the patient if necessary.
- Investigate for the broken limbs and provide the necessary treatment.
- If clothes must be removed, make sure to respect the injured person's privacy at all times.
- Ensure that the injured person is as comfortable as possible.
- If the injured person is unconscious, ascertain the degree of consciousness and possible cause and treat accordingly.
- Call an ambulance or injured person's doctor and relatives as soon as possible.
- Do not remove anything that is stuck to the wound.
- Never use sticky plaster on the wound.
- Cover the wound with a clean, lint-free cloth.
- Avoid using any oily substances or lotions on wound.
- If necessary, cool wounds with cold water.
- With burns, do not under any circumstances puncture the blister. (3 x 1) (3)

2.2 Reason to avoid standing in wet surroundings or having wet clothes and hands:

- To avoid getting shocked by the arc welding high voltage. ✓ (1)

2.3 The importance of ventilation during arc welding:

- To ensure the free flow of air to channel out the bad fumes ✓ caused by the burning flux which are harmful to human lungs. (2 x 1) (2)

2.4 The maximum gap is 3 mm. ✓ (1)

2.5 **Advantages of product layout of machines:**

- Handling of material is limited to a minimum. ✓
- Time period of manufacturing cycle is less. ✓
- Production control is almost automatic. ✓
- Control over operations is easier.
- Greater use of unskilled labour is possible.
- Less total inspection is required.
- Less total floor space is needed per unit of production.

(3 x 1) (3)
[10]

QUESTION 3: MATERIALS (GENERIC)**3.1 Machining test:**

- 3.1.1 Easy to cut ✓ (1)
- 3.1.2 Difficult to cut ✓ (1)
- 3.1.3 Easy to cut ✓ (1)
- 3.1.4 Difficult to cut ✓ (1)

3.2 Tests to identify various metals:**3.2.1 Sound test:**

- Tapping the metal with a hammer (any metal object) ✓ and identify the sound. ✓
- Dropping the metal on the floor ✓ and identify the sound. ✓
(Any 1 x 2) (2)

3.2.2 Spark test:

- Holding the metal against the grinding wheel in a dimly lit area ✓ and observe the colour, length and shape of the sparks. ✓ (2)

3.3 Purpose of heat treatment of steel

- To change ✓ the properties of steel. ✓
- To change ✓ the grain structure of steel. ✓ (Any 1 x 2) (2)

3.4 THREE factors for heat treatment of steel

- Heating temperature/Carbon content ✓
- Soaking (Time period at temperature)/Work piece size ✓
- Cooling rate/Quenching rate (Quenching medium) ✓ (3)

3.5 Quenching medium

- Water ✓
 - Oil ✓
 - Brine ✓ (Any 1 x 1) (1)
- [14]**

QUESTION 4: MULTIPLE CHOICE QUESTION (SPECIFIC)

4.1 C ✓

4.2 C ✓

4.3 C ✓

4.4 D ✓

4.5 B ✓

4.6 D ✓

4.7 B ✓

4.8 B ✓

4.9 C ✓

4.10 B ✓

4.11 C ✓

4.12 B ✓

4.13 A ✓

4.14 C ✓

[14]

QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)**5.1 Taper cutting****5.1.1 Calculating the small diameter**

$$\tan \frac{\theta}{2} = \frac{D-d}{2l} \checkmark$$

$$\tan \frac{10}{2} = \frac{165-d}{2(210)} \checkmark$$

$$\tan (5) \times 420 = 165 - d \checkmark$$

$$d = 165 - 36,75$$

$$d = 128,25 \text{ mm} \checkmark \quad (4)$$

5.1.2 Tailstock set-over

$$\begin{aligned} \text{Tailstock set-over} &= \frac{L(D-d)}{2l} \checkmark \\ &= \frac{325(165-128.25)}{2(210)} \checkmark \\ &= 28,44 \text{ mm} \checkmark \end{aligned}$$

(3)

5.2 Screw-cutting dial

- A Lead –screw
- B Scale/Dial
- C Wormwheel/Gear

5.3 Milling processes**5.3.1 A – Down-cut milling/Climb milling** ✓**Advantages:**

- Friction is absent ✓
- Reduction of Power for table feed ✓
- Deeper cuts can be taken
- A finer finish is obtained
- A better finish is obtained on some materials
- Less vibration is experienced

(3)

5.3.2 B – Up-cut milling/Conventional milling ✓**Disadvantages:**

- There is always a tendency for a cutter to lift the job ✓
- The finishing is not of high standard ✓
- Rapid tool wear due to friction

(3)

5.4 Advantages of balancing

- Reduce unwanted vibrations ✓
- Increase the efficiency of the machine ✓
- Ensures the longevity of parts ✓
- Improves surface finish ✓

(Any 2 x 1) (2)

[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)**6.1 Gear terminology**

$$6.1.1 \quad \text{Addendum} = m \\ = 3 \text{ mm} \checkmark \quad (1)$$

$$6.1.2 \quad \text{Dedendum} = 1,157 m \quad \text{OR} \quad = 1,25 m \\ = 1,157 \times 3 \checkmark \quad = 1,25 \times 3 \checkmark \\ = 3,47 \text{ mm} \checkmark \quad = 3,75 \text{ mm} \checkmark \quad (2)$$

$$6.1.3 \quad \text{Clearance} = 0,157 m \quad \text{OR} \quad = 0,25 m \\ = 0,157 \times 3 \checkmark \quad = 0,25 \times 3 \checkmark \\ = 0,47 \text{ mm} \checkmark \quad = 0,75 \text{ mm} \checkmark \quad (2)$$

$$6.1.4 \quad \text{Module} = \frac{PCD}{T}$$

$$PCD = m \times T \\ = 3 \times 48 \checkmark \\ = 144 \text{ mm} \checkmark \quad (2)$$

$$6.1.5 \quad OD = PCD + 2 m \\ = 144 + 2(3) \checkmark \\ = 144 + 6 \\ = 150 \text{ mm} \checkmark \quad (2)$$

$$6.1.6 \quad \text{Cutting depth} = 2,157 m \quad \text{OR} \quad = 2,25 m \\ = 2,157 \times 3 \checkmark \quad = 2,25 \times 3 \checkmark \\ = 6,47 \text{ mm} \checkmark \quad = 6,75 \text{ mm} \checkmark \quad (2)$$

$$6.1.7 \quad \text{Circular pitch} = m \times \pi \\ = 3 \times \pi \checkmark \\ = 9,42 \text{ mm} \checkmark \quad (2)$$

6.2 Angular indexing

$$\text{Indexing} = \frac{\text{Angle required}}{9} \checkmark$$

$$= \frac{47}{9} \checkmark$$

$$= 5 \frac{2}{9} \times \frac{6}{6}$$

$$= 5 \frac{12}{54} \checkmark$$

Indexing is 5 full turns, 12 holes in 54-hole circle $\checkmark$ (4)

6.3 Dovetail calculations

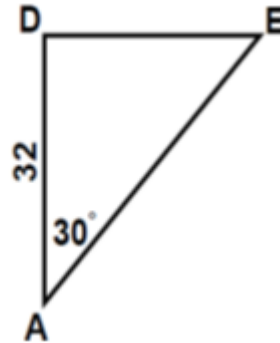
Calculate distance “x” between rollers:

$$X = 140 - 2(DE) + 2(AC) + 2(r)$$

$$Y = 140 - 2(DE)$$

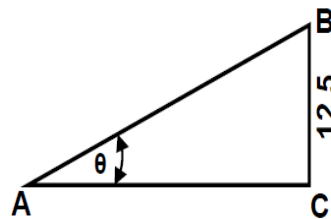
Calculating DE:

$$\begin{aligned} \tan \phi &= \frac{DE}{AD} \quad \checkmark \\ DE &= \tan \phi \times AD \quad \checkmark \\ &= \tan 30^\circ \times 32 \quad \checkmark \\ &= 18,48 \text{ mm} \quad \checkmark \end{aligned}$$



Calculating AC

$$\begin{aligned} \tan \phi &= \frac{BC}{AC} \quad \checkmark \\ AC &= \frac{BC}{\tan \phi} \quad \checkmark \\ &= \frac{12,5}{\tan 30^\circ} \quad \checkmark \\ &= 21,65 \text{ mm} \quad \checkmark \end{aligned}$$



Calculating Y

$$\begin{aligned} Y &= 140 - 2(DE) \\ &= 140 - 2(18,48) \quad \checkmark \\ &= 103,04 \text{ mm} \quad \checkmark \end{aligned}$$

Calculating X

$$\begin{aligned} X &= 140 - 2(DE) + 2(AC) + 2(r) \quad \checkmark \\ &= 140 - 2(18,48) + 2(21,65) + 2(12,5) \quad \checkmark \\ &= 103,04 + 43,3 + 25 \\ &= 171,34 \text{ mm} \quad \checkmark \end{aligned}$$

(11)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)**7.1 Precision measuring instrument**

7.1.1 Depth micrometer ✓
Vernier caliper (Any 1 x 1) (1)

7.1.2 Screw thread micrometer ✓ (1)

7.2 Depth micrometer reading

Reading = $50 + 1,5 + 0,49$ ✓
= 51,99 mm ✓ (2)

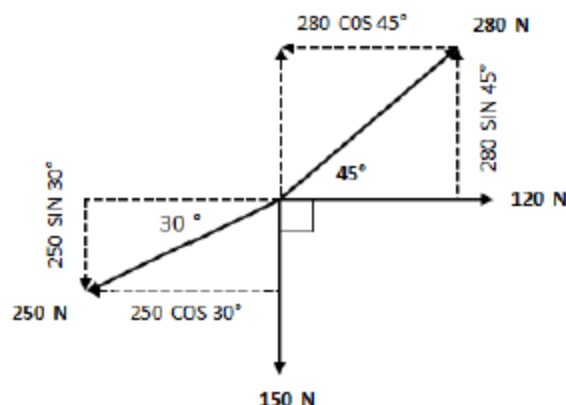
7.3 Brinnell hardness test

- Select the desired load to apply to the specimen. ✓
- The specimen is raised to be in contact with the Brinell ball by turning the hand wheel. ✓
- The load is then applied for about 15–30 seconds ✓
- Release the load from the specimen. ✓
- Measure the diameter of the impression. ✓
- Determine the Brinell hardness number. ✓ (6)

7.4 Tensile tester

- Yield stress ✓
- Ultimate/maximum tensile stress ✓
- Elongation percentage ✓
- Break stress ✓
- Limit of proportionality ✓
- Elastic limit ✓
- Strain ✓
- Ductility ✓ (Any 3 x 1) (3)

[13]

QUESTION 8: FORCES (SPECIFIC)**8.1 System of forces****8.1.1 Sum of horizontal components**

$$\begin{aligned}\sum HC &= 280 \cos 45^\circ + 120 \cos 0^\circ - 150 \cos 90^\circ - 250 \cos 30^\circ \\ &= 197,99 + 120 - 0 - 216,51 \\ &= 101,48 \text{ N} \checkmark\end{aligned}$$

OR

Force	HC (x)	Total
120 N	$120 \cos 0^\circ \checkmark$	120 N
280 N	$280 \cos 45^\circ \checkmark$	197,99 N
250 N	$250 \cos 210^\circ \checkmark$	-216,51 N
150 N	$150 \cos 270^\circ$	0 N
Total:		101,48 N $\checkmark$

(4)

8.1.2 Sum of vertical components

$$\begin{aligned}\sum VC &= 280 \sin 45^\circ + 120 \sin 0^\circ - 150 \sin 90^\circ - 250 \sin 30^\circ \\ &= 197,99 + 0 - 150 - 125 \\ &= -77,01 \text{ N} \checkmark\end{aligned}$$

OR

Force	VC (y)	Total
120 N	$120 \sin 0^\circ$	0 N
280 N	$280 \sin 45^\circ \checkmark$	197,99 N
250 N	$250 \sin 210^\circ \checkmark$	-125 N
150 N	$150 \sin 270^\circ \checkmark$	-150 N
Total:		-77,01 N $\checkmark$

(4)

8.1.3 Magnitude of the equilibrant

$$E^2 = VC^2 + HC^2 \quad \checkmark$$

$$E = \sqrt{(77,01)^2 + (101,48)^2} \quad \checkmark$$

$$= 127,39 \text{ N} \quad \checkmark$$

(3)

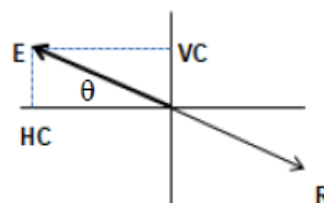
8.1.4 Angle and the direction of the equilibrant

$$\tan \theta = \frac{VC}{HC} \quad \checkmark$$

$$\tan \theta = \frac{77,01}{101,48}$$

$$\theta = 37,19^\circ \quad \checkmark$$

$$E = 127,39 \text{ N at } 37,19^\circ \text{ N of W} \quad \checkmark$$



8.2 Stress and Strain

8.2.1 Area

$$A = \frac{\pi(D^2 - d^2)}{4} \quad \checkmark$$

$$= \frac{\pi(0,056^2 - 0,038^2)}{4}$$

$$= 1,33 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

(2)

8.2.2 Stress

$$\text{Stress} = \frac{\text{force}}{\text{area}} \quad \checkmark$$

$$\text{Stress} = \frac{20 \times 10^3}{1,33 \times 10^{-3}} \quad \checkmark$$

$$= 15037593,98 \text{ Pa}$$

$$\text{Stress} = 15,04 \text{ MPa} \quad \checkmark$$

(3)

8.2.3 Strain

$$\text{Strain} = \frac{\Delta l}{OL} \quad \checkmark$$

$$\text{Strain} = \frac{50 - 49,975}{50} \quad \checkmark$$

$$\begin{aligned} \text{Strain} &= \frac{0,025}{50} \\ &= 0,5 \times 10^{-3} \quad \checkmark \end{aligned}$$

(3)

8.2.4 Young's Modulus of Elasticity

$$\text{Youngs Modulus of Elasticity} = \frac{\text{Stress}}{\text{Strain}} \quad \checkmark$$

$$E = \frac{15,04 \times 10^6}{0,5 \times 10^{-3}} \quad \checkmark$$

$$= 30,08 \times 10^9 \text{ Pa}$$

$$= 30,08 \text{ GPa} \quad \checkmark$$

(3)

8.3 Moments

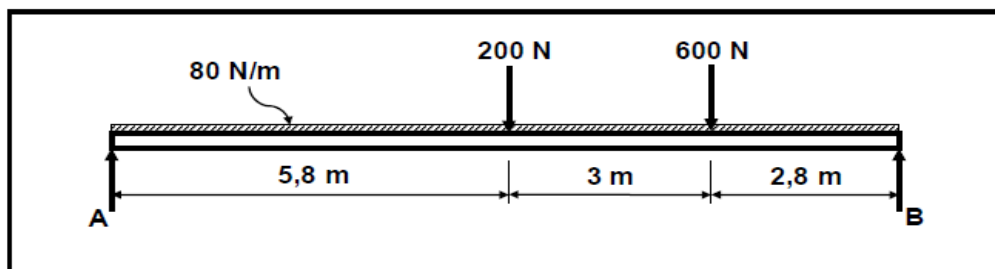


FIGURE 8.3

8.3.1 Uniform Distributed Load

$$\begin{aligned} &80 \text{ N/m} \times 11,6 \text{ m} \quad \checkmark \\ &= 928 \text{ N} \quad \checkmark \end{aligned}$$

(2)

8.3.2 Calculate A. Moments about B

$$\sum \text{RHM} = \sum \text{LHM} \quad \checkmark$$

$$(A \times 11,6) = (200 \times 5,8) + (928 \times 5,8) + (600 \times 2,8) \quad \checkmark$$

$$11,6A = 1160 + 5382,4 + 1680$$

$$\frac{11,6A}{11,6} = \frac{8222,4}{11,6}$$

$$A = 708,83 \text{ N} \quad \checkmark$$

(3)

8.3.3 Calculate B. Moments about A

$$\begin{aligned}
 \sum LHM &= \sum RHM && \checkmark \\
 (B \times 11,6) &= (600 \times 8,8) + (928 \times 5,8) + (200 \times 5,8) && \checkmark \\
 11,6B &= 5280 + 5382,4 + 1160 \\
 \frac{11,6B}{11,6} &= \frac{11822,40}{11,6} && \checkmark \\
 B &= 1019,17 \text{ N}
 \end{aligned}$$

(3)

[33]**QUESTION 9: MAINTENANCE**

9.1 Lack of preventative maintenance:

- Risk of injury or death ✓
- Financial loss ✓
- Damage to parts ✓
- Loss of production time ✓

(Any 2 x 1) (2)

9.2 Mechanical drive systems maintenance

9.2.1 Gear drive

- Checking and replenishing of lubrication levels ✓
- Ensuring that gears are properly secured to shafts ✓
- Cleaning and replenishing of oil filters ✓
- Reporting excessive noise and wear ✓
- Reporting vibrations and overheating ✓

(Any 2 x 1) (2)

9.2.2 Belt drive

- Checking for wear and tear on belt ✓
- Checking belt alignment ✓
- Checking the tension setting ✓
- Checking the tension devices ✓

(Any 2 x 1) (2)

9.3 Factors that influence the coefficient of friction between two materials

- Contact pressure ✓
- Surface roughness ✓
- Temperature ✓
- Sliding velocity ✓
- Type of lubricant ✓

(Any 3 x 1) (3)

9.4 Flash point

- It is the lowest temperature at which the oil gives off vapours which can ignite. ✓✓

(2)

9.5 Polyester resin ✓ (1)

9.6 Properties of materials

9.6.1 Polyvinyl chloride (PVC)

- Can be re-heated and re-shaped ✓
- Flexible ✓
- Rubber like substance and makes a dull sound when dropped. ✓
- Can be modified to suit most applications. ✓
- Can be welded (plastic welding). ✓
- Can be bonded with an adhesive. ✓
- Weather resistant ✓
- Waterproof ✓
- Easy to work with ✓
- Light weight ✓
- Recyclable ✓
- Corrosion resistant ✓

(Any 2 x 1) (2)

9.6.2 Carbon fibre

- Cannot be re-heated and re-shaped ✓
- Tough and strong material. ✓
- Light weight ✓
- Weather resistant ✓
- Heat resistant ✓
- Enhance strength of plastic by entrenchment. ✓
- Highly electrically conductive ✓

(Any 2 x 1) (2)

9.6.3 Bakelite

- Electrically non-conductor (electrical insulator) ✓
- Heat resistant ✓
- Well moulded into specific shapes ✓
- Weather resistant ✓
- Cannot be re-heated and re-shaped ✓

(Any 2 x 1) (2)

[18]

QUESTION 10: JOINING METHODS (SPECIFIC)**10.1 Uses of square thread**

- Vice screws ✓
- Brake screws ✓
- Lead screws of lathe machines ✓
- Scissor jacks ✓
- Milling machine table feed screws ✓
- Hydraulic jacks (Adjustable top) ✓ (2)

10.2 V-screw thread

- 10.2.1 A Pitch diameter/mean/effective ✓
 B Helix angle ✓
 C Pitch / Lead ✓
 D Root/Root length ✓ (4)

10.2.2 60° ✓ (1)

10.3 Square thread calculations:

10.3.1 Lead = Pitch × number of starts
 $= 7 \times 2$ ✓
 $= 14 \text{ mm}$ ✓ (2)

10.3.2 Pitch diameter = OD - $\frac{1}{2}$ pitch
 $= 84 - \frac{1}{2}(7)$ ✓
 $= 80.5 \text{ mm}$ ✓ (2)

10.3.3 Helix angle: $\tan \theta = \frac{\text{lead}}{\text{pitch circumference}}$
 $\tan \theta = \frac{14}{\pi \times 80.5}$ ✓✓
 $\theta = \tan^{-1}(0,05535\dots)$
 $\theta = 3,17^\circ$ ✓ (3)

10.3.4 Leading tool angle = $90^\circ - (\text{helix} + \text{clearance angle})$
 $= 90^\circ - (3,17^\circ + 3^\circ)$ ✓
 $= 83,83^\circ$ ✓ (2)

10.3.5 Following tool angle = $90^\circ + (\text{helix} - \text{clearance angle})$
 $= 90^\circ + (3,17^\circ - 3^\circ)$ ✓
 $= 90,17^\circ$ ✓ (2)

[18]

QUESTION 11: SYSTEMS AND CONTROL (SPECIFIC)**11.1 Advantages of chain drive system over belt drive systems:**

- No slipping or creep occurs. ✓
- Higher efficiency. ✓
- Longer life span. ✓
- Does not generate heat. ✓
- Does not undergo the same degrading effects of what time has on belts. ✓
- Much stronger. ✓
- Faster speeds can be obtained. ✓

(Any 3 x 1) (3)

11.2 Gear drives:**11.2.1 The rotation frequency of the electric motor**

$$\frac{N_{input}}{N_{output}} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$\frac{N_{input}}{800} = \frac{22 \times 40}{40 \times 18} \quad \checkmark$$

$$N_A = \frac{22 \times 40 \times 800}{40 \times 18} \quad \checkmark$$

$$N_A = 977.78 \text{ r/min} \quad \checkmark$$

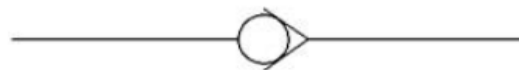
$$N_A = 16.30 \text{ r/sec} \quad \checkmark \quad (4)$$

11.2.2 The speed ratio

$$\text{Speed ratio} = \frac{\text{Driven}}{\text{Driver}} \quad \checkmark$$

$$= \frac{880}{720} \quad \checkmark$$

$$= 1.22 : 1 \quad \checkmark \quad (3)$$

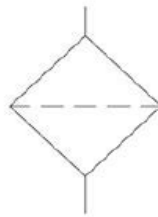
11.3 Symbols**11.3.1 Non-return valve**

Standard symbol

✓✓

(2)

11.3.2 Filter



Basic Filter

✓✓

(2)

11.4 Types of hydraulic pumps

- Reciprocating pumps or Piston ✓
- Rotary pumps or Gear or Vane ✓

(2)

11.5 Functions of a reservoir in a hydraulic system

- A fluid storage tank. ✓
- Promotes air separation from the fluid. ✓
- Support for the pump and electric motor. ✓
- Promotes heat dispersion. ✓
- Acts as a base plate for mounting control equipment. ✓
- It allows for expansion or contraction of the hydraulic system. ✓

(2)

11.6 Hydraulic calculations:

11.6.1 Fluid pressure

Area:

$$A_A = \frac{\pi D_A^2}{4}$$

$$= \frac{\pi (0,025)^2}{4} \quad \checkmark$$

$$= 0,49 \times 10^{-3} \text{ m}^2 \quad \text{OR} \quad 4,91 \times 10^{-4} \text{ m}^2 \quad \checkmark$$

Pressure:

$$P = \frac{F}{A}$$

$$= \frac{1,32 \times 10^3}{0,49 \times 10^{-3}} \quad \checkmark$$

$$= 2,69 \times 10^6 \text{ Pa}$$

$$= 2,69 \text{ MPa} \quad \checkmark$$

(4)

11.6.2 Diameter of piston B

$$P_B = P_A$$

$$\frac{F_B}{A_B} = \frac{F_A}{A_A}$$

$$\frac{6,45 \times 10^3}{A_B} = \frac{1,32 \times 10^3}{0,49 \times 10^{-3}} \checkmark$$

$$\frac{6,45 \times 10^3}{A_B} = 2,69 \times 10^6$$

$$A_B = \frac{6,45 \times 10^3}{2,69 \times 10^6} \checkmark$$

$$A_B = 2,40 \times 10^{-3} \checkmark$$

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

$$D_B = \sqrt{\frac{4A_B}{\pi}} \checkmark$$

$$= \sqrt{\frac{4(2,40 \times 10^{-3})}{\pi}} \checkmark$$

$$= 0,05528 \text{ m}$$

$$= 55,28 \text{ mm} \checkmark$$

(6)

[28]**TOTAL: 200**