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Question 1: (4 points)

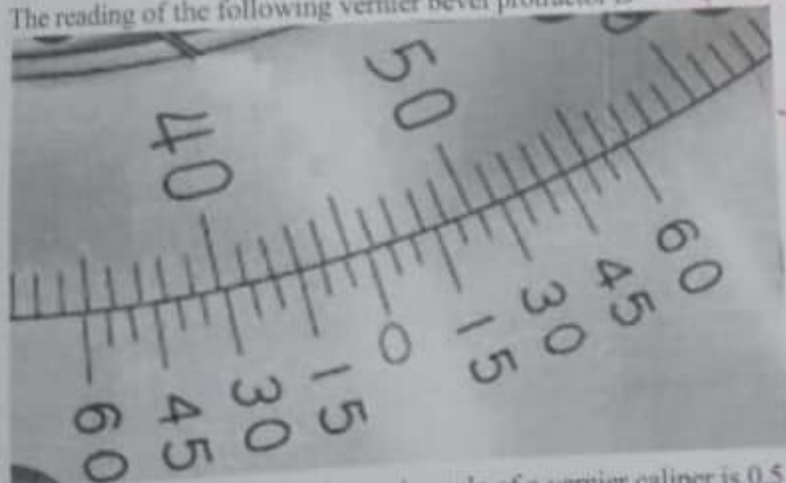
Select the best answer for each of the following paragraph

1. We can use the gauge blocks to check the calibration of the vernier caliper or the micrometer
☒ A. True ☐ B. False
2. In the vernier caliper the size of division on the main scale is always greater than the size of division on the vernier scale, and the difference between the two values equal the size of division on the main scale divided by the number of divisions on the vernier scale.
☒ A. True ☐ B. False
3. In the vernier caliper the size of division on the main scale is always greater than the size of division on the vernier scale, and the difference between the two values equal the accuracy of the device.
☐ A. True ☒ B. False
4. When measuring a dimension using the micrometer the workpiece is fixed between two parts of the micrometer (the anvil and the spindle), the spindle is the fixed part of the micrometer, while the anvil is the movable part.
☒ A. True ☐ B. False

Question 2: (6 points)

Fill in the space

1. The reading of the following vernier bevel protractor is $45^{\circ} 45'$, and the accuracy is $5'$.



2. If the smallest division on the main scale of a vernier caliper is 0.5 mm and the number of divisions on its vernier scale is 25 divisions, then the accuracy of the device is 0.02 mm, and the error of the device is ± 0.01 mm.

$$\frac{0.5}{25} = 0.02$$

Question 3: (8 points)

A bench micrometer was used to measure the dimensions for an external thread; the readings are given as:

- The reading over the thread = 9.6270 mm
- The reading over the cylinder = 9.7166 mm
- The reading over the thread (with wires) = 10.0716 mm
- The reading over the cylinder (with wires) = 13.2788 mm
- The reading over the thread (with prisms) = 11.9306 mm
- The reading over the cylinder (with prisms) = 15.5414 mm

And you know that the diameter of the standard cylinder is equal to 15.0000 mm, the flank angle of the thread (θ) = 30° , the diameter of the wire (d) = 2.0207 mm, and the pitch size of the thread (p) = 3.5 mm

The effective diameter equation is

$$D_{eff} = T + \frac{p}{2} \cot \theta - (\operatorname{cosec} \theta - 1) \cdot d$$

where T is the dimension under the wires

Calculate the major diameter, the minor diameter, and the effective diameter of the thread. (Show your calculations)

1. major diameter

$$\begin{aligned} D_{th} &= D_c + (R_{th} - R_c) \\ &= 15 + (9.627 - 9.7166) = 14.9104 \text{ mm} \end{aligned}$$

2. minor diameter

$$\begin{aligned} D_{th}(\text{prisms}) &= D_c + (R_{th}(\text{prisms}) - R_c(\text{prisms})) \\ &= 15 + (11.9306 - 15.5414) = 11.3892 \text{ mm} \end{aligned}$$

3. effective diameter

$$\begin{aligned} T &= D_c + (R_{th}(\text{wires}) - R_c(\text{wires})) \\ &= 15 + (10.0716 - 13.2788) = 11.7928 \text{ mm} \end{aligned}$$

$$2x = \frac{3.5}{2} \cot(30) - (\operatorname{cosec}(30) - 1) \times 2.0207 = 1.0103 \text{ mm}$$

$$D_{eff} = T + 2x = 11.7928 + 1.0103 = 12.803 \text{ mm}$$

Question 4: (4 points)

What is the minimum number of blocks that will be used to produce an overall dimension of 18.7775 mm. Show your calculations.

4/4

Note: remember to include the wearing blocks.

Pieces		Increment
One piece	1.0005	
9 pieces	1.001-1.009	
49 pieces	1.01-1.49	0.001
19 pieces	0.5-9.5	0.01
9 pieces	10-90	0.5
2 pieces (wearing block)	2 mm each one	10

Handwritten calculations for Question 4:

18.7775
~~4.0000~~ (1 block)
 14.7775
~~1.0005~~ (1 block)
 13.777
~~1.007~~ (1 block)
 12.77
~~1.27~~ (1 block)
 11.5
~~2.6~~ (1 block)
 8.9
~~10~~ (1 block)
 -10
 -0.1

Handwritten calculations for Question 4:

18.7775
~~4.000~~ (2 block)
 14.7775
~~1.0005~~ (1 block)
 13.777
~~1.007~~ (1 block)
 12.77
~~1.27~~ (1 block)
 11.5
~~1.5~~ (1 block)
 10
~~10~~ (1 block)
 0

7 blocks used

Question 5: (8 points)

A. Describe Abbess' principle, and provide an example for a device that follows Abbess' principle. (3 points)

B. Compare between line standard and end standard devices. (2 points)

C. Describe the working principle of the clinometer. (3 points)

End