9. In the RTD experiment , the relationship between the Resistance and temperature is linear.
A. True
B. False

10. Thermi stors are
A. Less sensitive than RTDs
B. More sensitive than RTDs

11. With all co mmon types of RTD, the resistance increases as Temperature increases.
A. True
B. False

12. RTDs t ypically have much higher nominal resistance values than thermistors.
A. True
B. False

13. -__________ refers to the predominant direction of the surface texture.
A. Form
B. Lay
C. Profile
D. Center line

14. The inside micrometer is one of the indirect measuring instruments
A. True
B. False

Question 2:
Define the following Terminology from the Surface Texture Experiment. 9 Points

A. Roughness

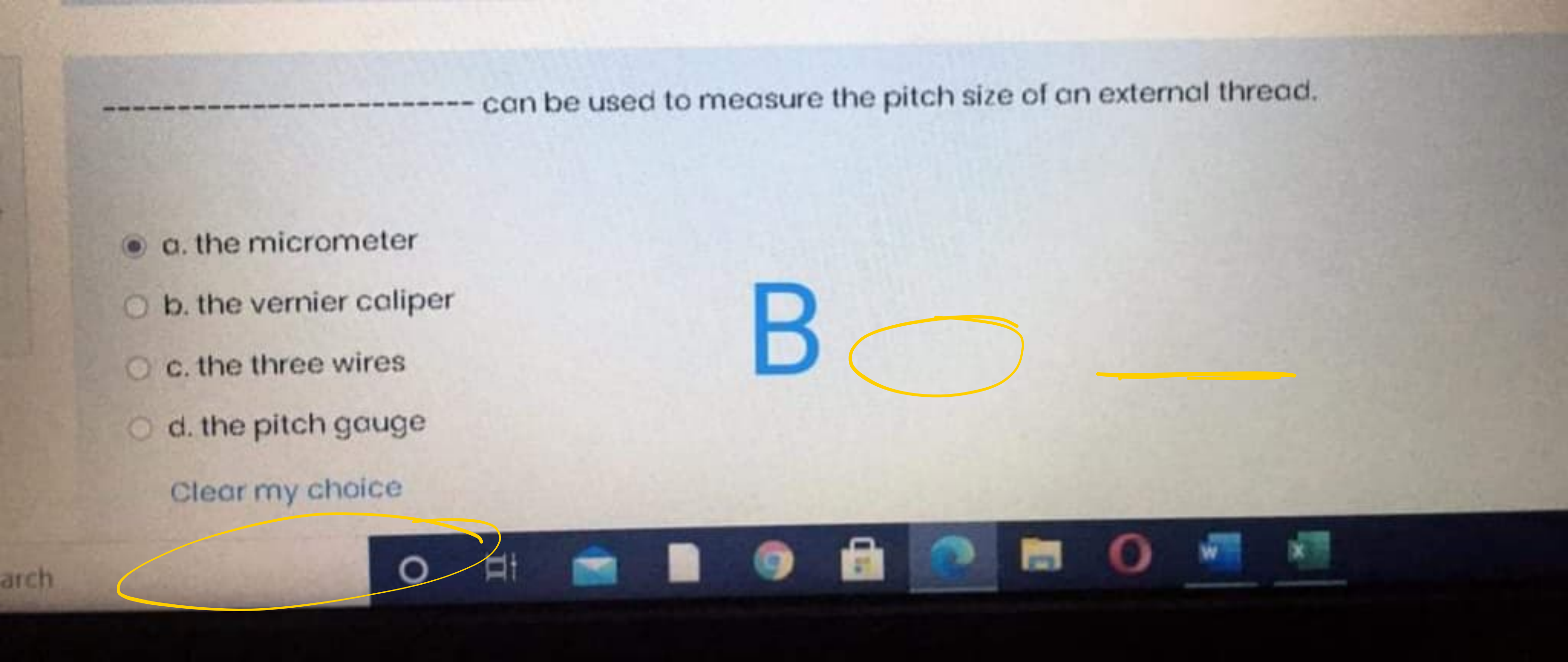
B. Waviness

C. Lay

D. Profile

E. Center line

F. Form



------------------------- can be used to measure the pitch size of an external thread.

● a. the micrometer

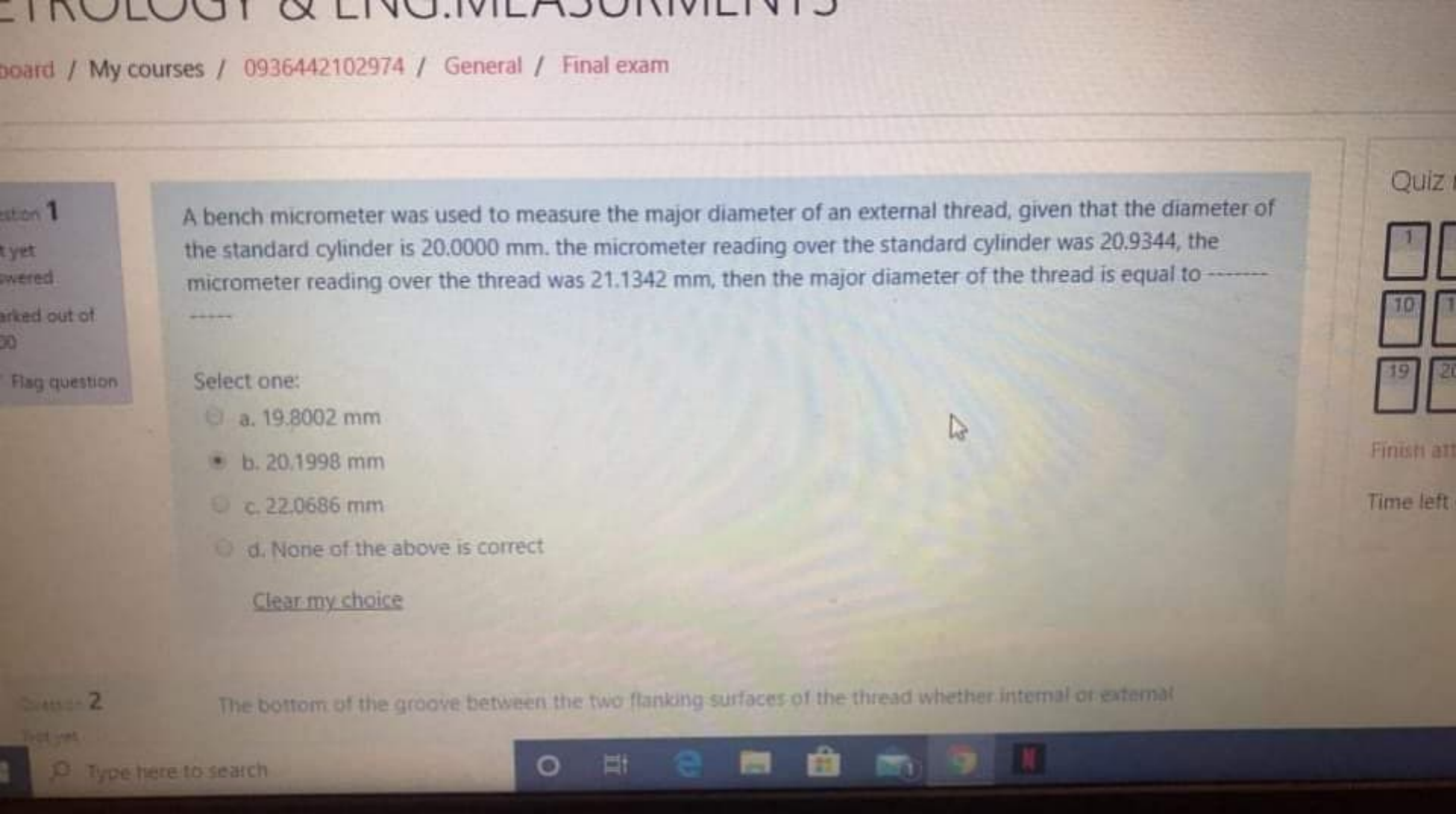
○ b. the vernier caliper

○ c. the three wires

○ d. the pitch gauge

Clear my choice

B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A bench micrometer was used to measure the major diameter of an external thread, given that the diameter of the standard cylinder is 20.0000 mm. the micrometer reading over the standard cylinder was 20.9344, the micrometer reading over the thread was 21.1342 mm, then the major diameter of the thread is equal to -------------

Select one:

○ a. 19.8002 mm

● b. 20.1998 mm

○ c. 22.0686 mm

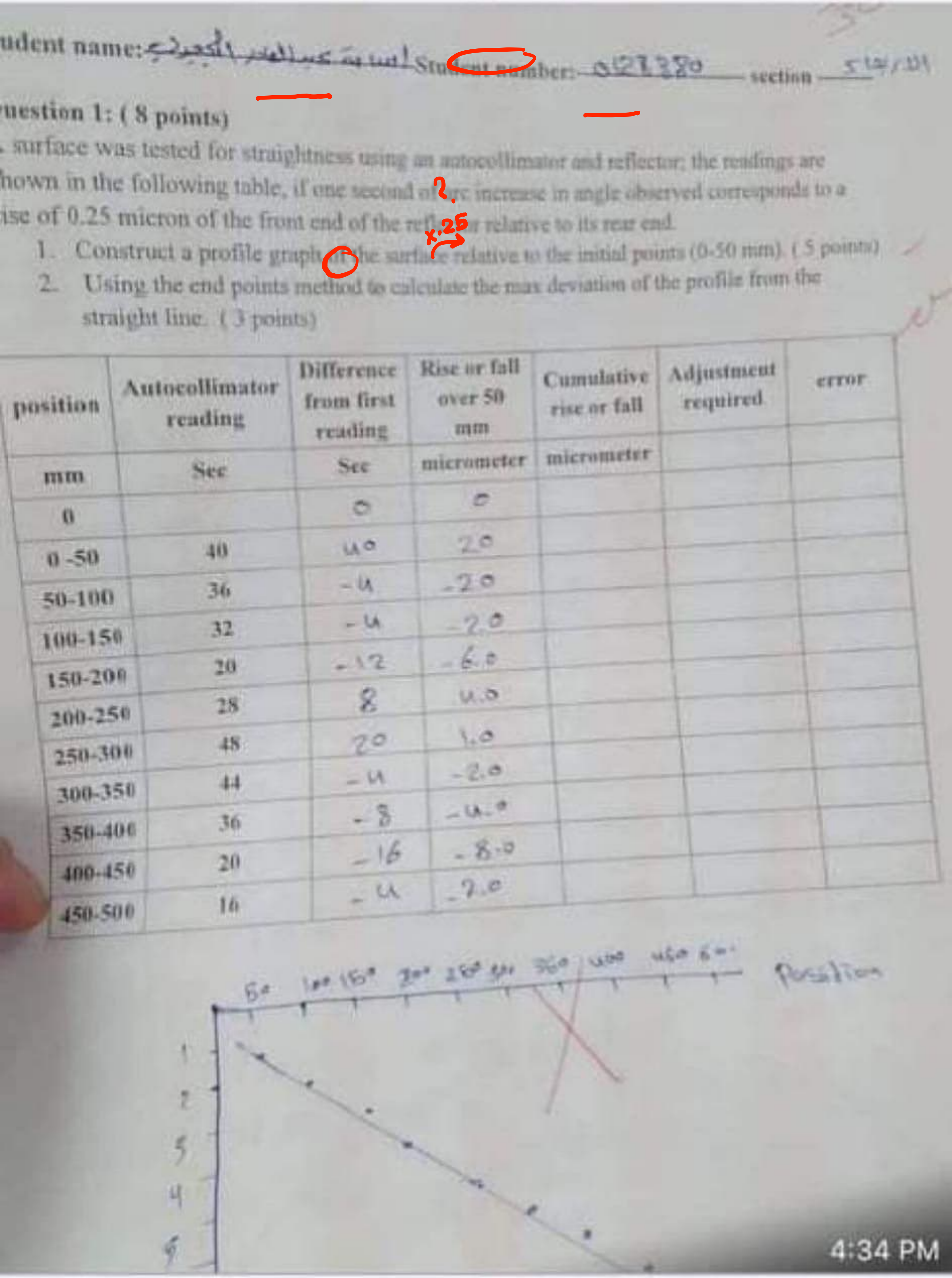
○ d. None of the above is correct

Clear my choice

Question 2

Not yet

The bottom of the groove between the two flanking surfaces of the thread whether internal or external



udent name: اسامه عبدالقادر الكعيري Student number: 0121380 section [illegible]

uestion 1: (8 points)

 surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	Sec	micrometer	micrometer		
0		0	0			
0 -50	40	40	20			
50-100	36	-4	-2.0			
100-150	32	-4	-2.0			
150-200	20	-12	-6.0			
200-250	28	8	4.0			
250-300	48	20	1.0			
300-350	44	-4	-2.0			
350-400	36	-8	-4.0			
400-450	20	-16	-8.0			
450-500	16	-4	-2.0			

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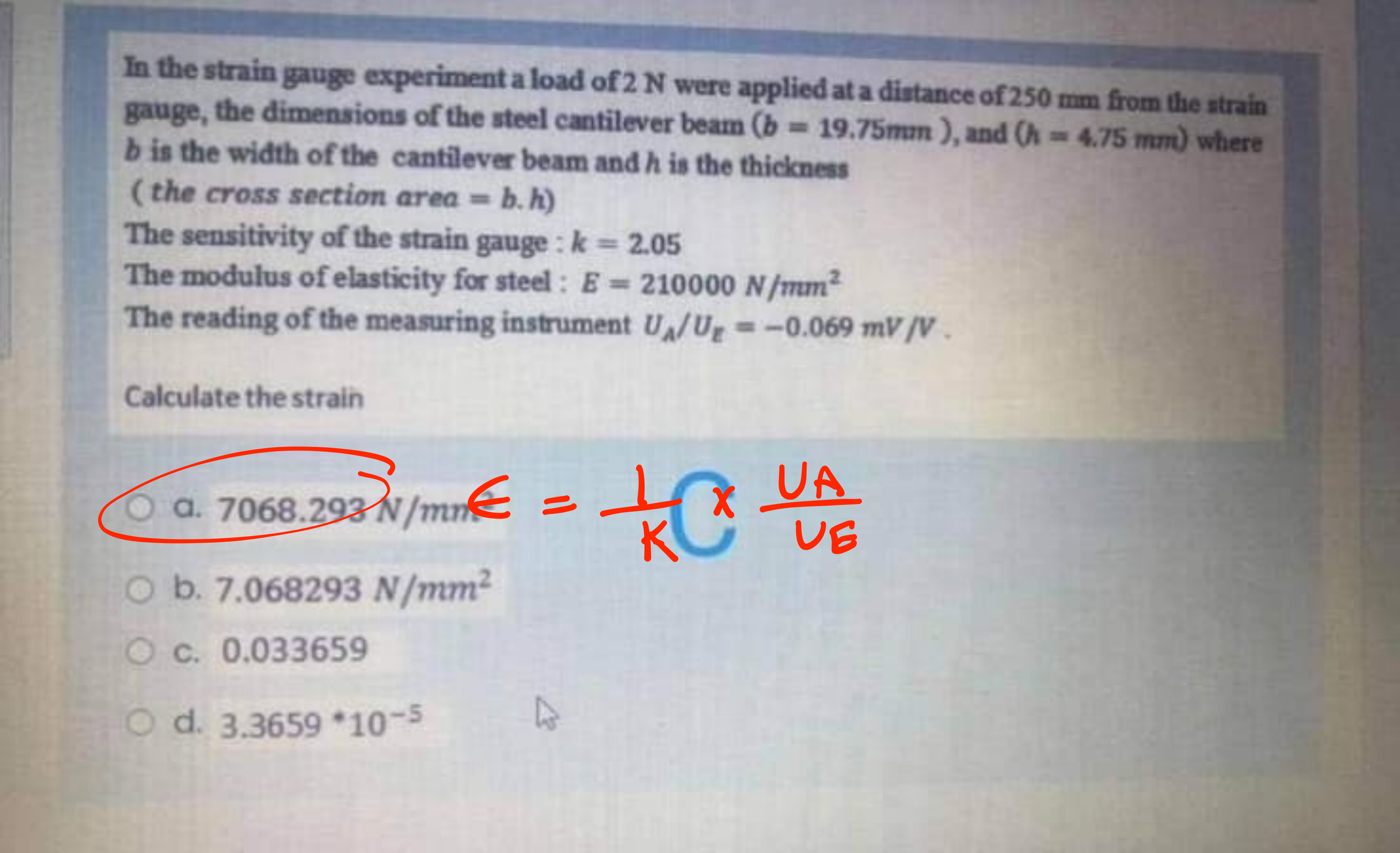


In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge, the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75\ mm$) where b is the width of the cantilever beam and h is the thickness

($the\ cross\ section\ area = b.h$)

The sensitivity of the strain gauge : $k = 2.05$

The modulus of elasticity for steel : $E = 210000\ N/mm^2$

The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$.

Calculate the strain

○ [✓ a. 7068.293 N/mm^2]

$$\epsilon = \frac{1}{K} \times \frac{UA}{UE}$$

○ b. 7.068293 N/mm^2

○ c. 0.033659

○ d. 3.3659 $*10^{-5}$

10

Question 1:

10 points

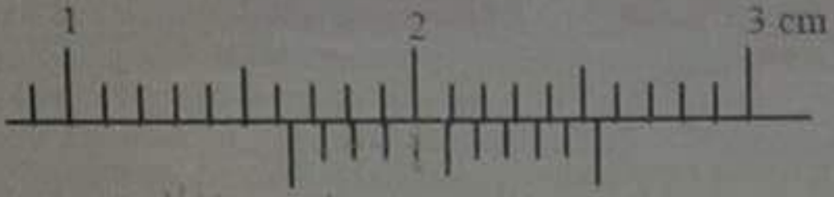
A. What size is the gauge block build-up used with a 5 inches sine bar to set the workpiece at an angle of 4° 30'? show your calculations (3 points)

$\theta = 4.5^\circ$ L = 5 inche = 12.7 cm

1

$\sin\theta = \frac{h}{L}$ = $h = \sin 4.5^\circ \times 12.7$ = 0.9996 cm = 0.393 inch

B. A student used a vernier caliper to measure the diameter of a cylinder. The diagram shows an enlargement of the caliper scales. What reading was recorded? (2 points)

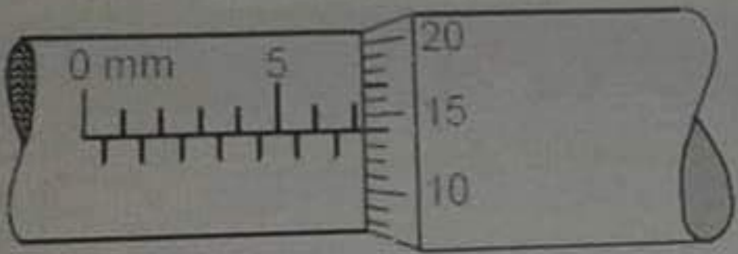


2

11m + 0.1 × 4 = 11.4 mm

C. What is the reading of the following micrometer? (2 points)

$\frac{0.5}{50}$



7 mm + 0.14 mm =

7.14 mm

D. Using the following set of gauge blocks, what is the minimum number of blocks to be wrung together to produce an overall dimension of 47.765 mm

Show your calculations (3 points)

Metric 103 pieces	
	Increment
1 piece (1.005) mm	
49 pieces (1.01-1.49) mm	0.01 mm
49 pieces (0.5-24.5) mm	0.5 mm
4 pieces (25-100) mm	25 mm

25

we need 5 block gauge

47.765
① 1.005
46.760
② 1.26
45.50
③ 0.5 −
45.0
④ 25.00 −
20.00
⑤ 20.00 −
0.00

2

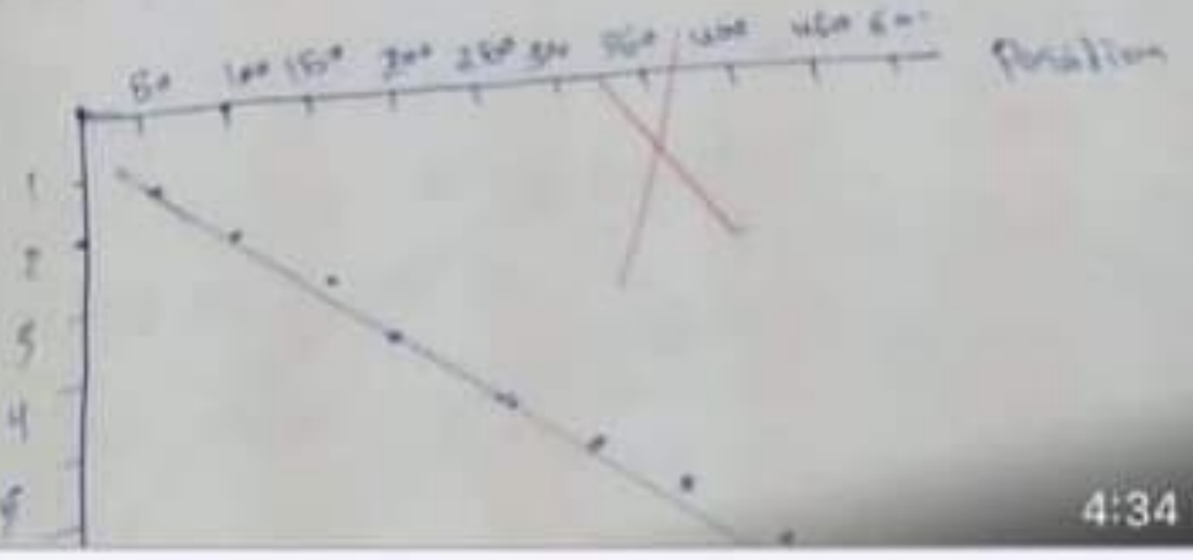
udent name: اسيه عبد السلام الجبوري Student number: 0121380 section 5 ١٢/١١

uestion 1: (8 points)

. surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	Sec	micrometer	micrometer		
0		0	0			
0 -50	40	40	20			
50-100	36	-4	-2.0			
100-150	32	-4	-2.0			
150-200	20	-12	-6.0			
200-250	28	8	4.0			
250-300	48	20	1.0			
300-350	44	-4	-2.0			
350-400	36	-8	-4.0			
400-450	20	-16	-8.0			
450-500	16	-4	-7.0			



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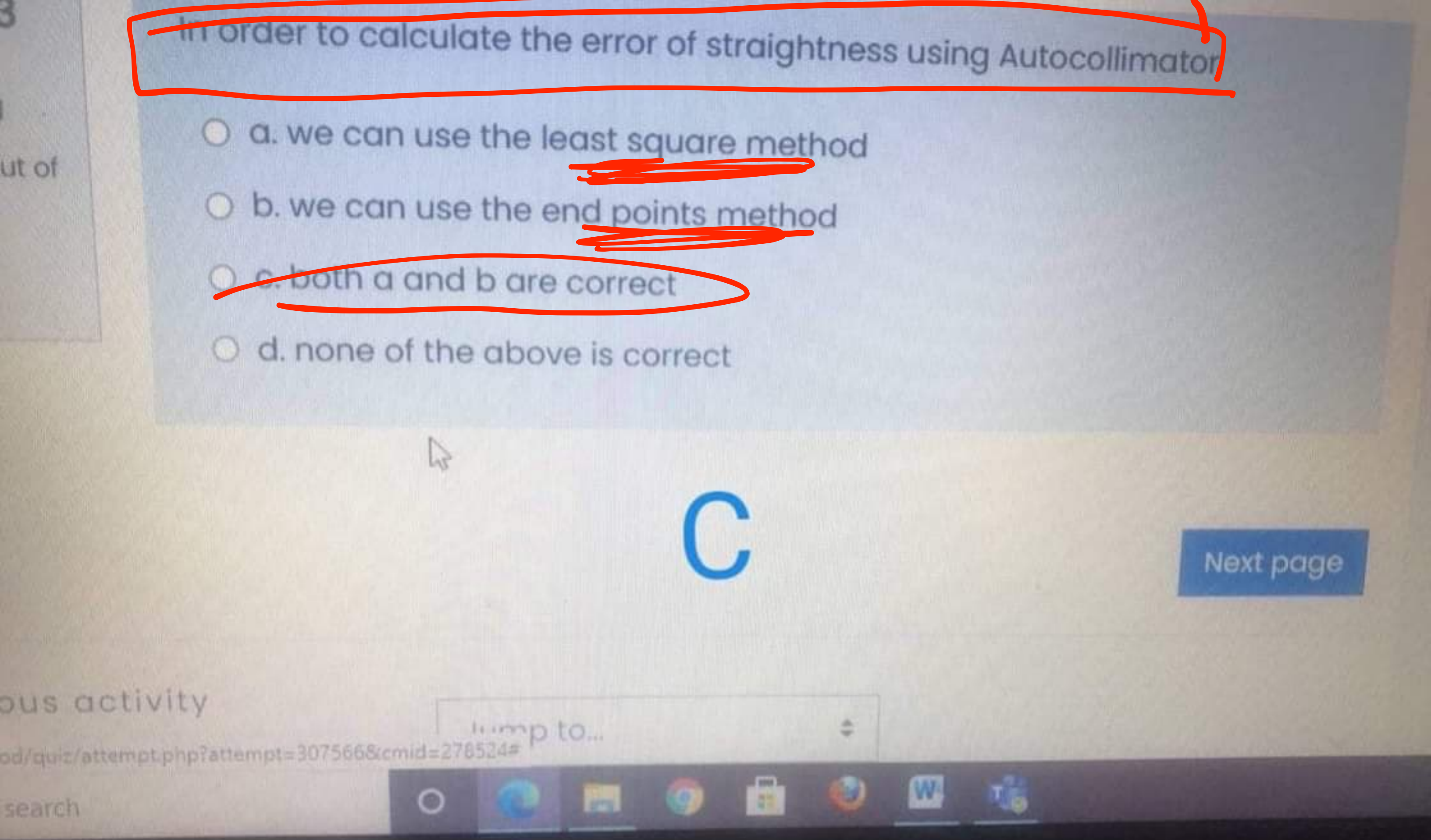
Q1

1) B
2) D
3) A
4) A
5) A
6) C
7) C
8) B
9) A
10) A
11) A
12) B
13) A
14) B

9) True
10) A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In order to calculate the error of straightness using Autocollimator

○ a. we can use the least square method

○ b. we can use the end points method

○ c. both a and b are correct

○ d. none of the above is correct

C

Question 3: (4 points)

Using the following set of gauge blocks, list the minimum number of blocks to produce an overall dimension of 100.995 mm. (show your calculations)

Metric (103) pieces	**Increment**
1 piece (1.005) mm	
49 pieces (1.01 to 1.49) mm	0.01
49 pieces (0.5 to 24.5) mm	0.5
4 pieces (25- 100) mm	25

100.995
1 .005
99.99
1.49
98.5
24.5
74.00
- 24.00
50.00
- 50.00
0 0

3/4

98.9
- 1.49
98.5 - 24.5
74.00

B. Why do we always choose the minimum number of blocks combinaton?

because accuracy Reading end standard measurment & calibration

6/6

Question 4: (6 points)

Describe the working principle of the clinometer

Colominilor its device using for angular measurment how colominar on face aligned for each other put the colominar if face check the reading of Bubble equal zero if not you have more knap and reverstal untill the Babble gives zero reading colominator consist of two Scale main Scale in degree vernier Scale The reading in second by reverse work pices afte that add all resar to set the movement of all alligned measure angle

Q2

A is a component of surface texture.

B measurment of the more widely spaced component of surface texture

C

9. In the RTD experiment , the relationship between the Resistance and temperature is linear.
A. True
B. False

10. Thermi stors are
A. Less sensitive than RTDs
B. More sensitive than RTDs

11. With all co mmon types of RTD, the resistance increases as Temperature increases.
A. True
B. False

12. RTDs t ypically have much higher nominal resistance values than thermistors.
A. True
B. False

13. -____________ refers to the predominant direction of the surface texture.
A. Form
B. Lay
C. Profile
D. Center line

14. The inside micrometer is one of the indirect measuring instruments
A. True
B. False

Question 2:
Define the following Terminology from the Surface Texture Experiment. 9 Points

A. Roughness

B. Waviness

C. Lay

D. Profile

E. Center line

F. Form

Question 2:

Describe the working principle of the Clinometer **6 points**

6

Clinometer (3+1) device using for angular measurement [illegible] to [illegible] from [illegible] when I put the clinometer on the [illegible] the reading of bubbles equal zero if [illegible] have to make [illegible] and [illegible] with the bubbles [illegible] reading clinometer consist of two scale [illegible] scale in degree [illegible] scale in minutes [illegible] get the reading in second [illegible] after that [illegible] reading [illegible] 9th

Question 3: **14 points**

A surface was tested for straightness using an autocollimator and a reflector; the readings are shown in the following table. If one second of arc rotation in angle [illegible] corresponds to a rise of [illegible] micron of the front end of the reflector relative to its rear end.

A. Construct a profile graph of the surface relative to the initial point (0-50). (4 points)

B. Calculate the maximum deviation of the profile from the straight line using the least square method. (10 points)

the [illegible] of [illegible] of angle

A.

Position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	[illegible]	[illegible]	x_i $(x-\bar{x})$	y_i $(y-\bar{y})$	$x_i y_i$	y_i
mm	sec	sec	micron	micron						
0	0	0	0	0	0		-250	-3.7	936	-4.38
0-50	22	0	0	0	1	1	-200	-3.7	740	-4.22
50-100	20	-2	-0.5	-0.5	2	1.5	-150	-4.2	630	-3.47
100-150	18	-4	-1	-1.5	3	1.5	-100	-5.2	520	-3.53
150-200	12	-10	-2.5	-4	4	0	-50	-7.7	385	-3.77
200-250	16	-6	-1.5	-5.5	5	-1.5	0	-9.2	0	-4.43
250-300	26	4	1	-4.5	6	1.5	50	-8.2	-410	[illegible]
300-350	24	2	0.5	-4	7	1	100	-7.7	-770	[illegible]
350-400	20	-2	-0.5	-4.5	8	1.5	150	-8.2	-1230	[illegible]
400-450	12	-10	-2.5	-7	9	-2	200	-10.7	-2140	[illegible]
450-500	19	-3	-0.75	-7.75	10	0	250	-11.45	[illegible]	

250

[illegible] $\bar{y}$ -3.7?

$$m = \frac{\sum y_i x_i}{\sum x_i^2} = \frac{-4475}{275000} = -0.017$$

$y = -0.017x + 0.48$

$c = \bar{y} - m\bar{x}$

$c = -3.7 - (-0.017 \times 250)$

$c = 0.48$

Straightness error = $\frac{1.38 - (-0.55)}{\text{max} - \text{value}}$ = 1.47 [illegible]

err → -4.18, -4.27, -3.48, -3.13, -4.78, -5.43, -3.58, -2.31, -1.37, -1.5?, [illegible]

stion 1: 6 points

In the strain gauge experiment a load of 3 N were applied at a distance of 250 mm from the strain gauge, the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75\ mm$) where b is the width of the cantilever beam and h is the thickness

($the\ cross\ section\ area = b.h$)

The sensitivity of the strain gauge : $k = 2.05$

The modulus of elasticity for steel : $E = 210000\ N/mm^2$

The reading of the measuring instrument $U_A/U_E = -0.104\ mV/V$.

Calculate the strain(ε), the experimental value of the stress (σ), and the theoretical value of the stress (σ).

2|6

$$A = b.h$$

$$= 19.75 \times 4.75$$

$$= 93.8125$$

$$\boxed{\varepsilon = 2.05 * (-0.104 - 1)}$$

$$= -2.2632$$

$$\boxed{\sigma = E\ \varepsilon}$$

$$= 210000 * -2.2632$$

$$= -475272$$

Question 5: 8 Points

A. Describe the working principle of the clinometer.

the clinometer is special case of the application of sipird level in this instance level is mountor in relatable body carried in housing are face of which forms the base of an instrument

no

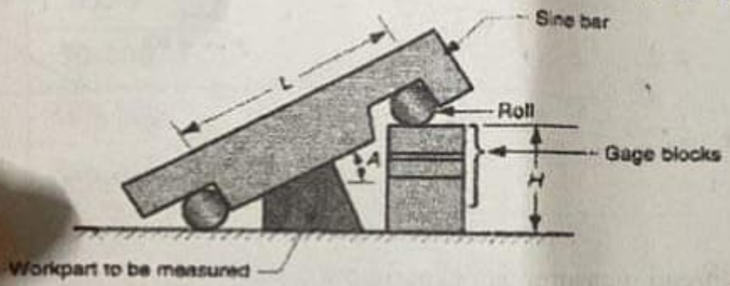
?

B. A sine bar was used to measure the angle (A) of a certain specimen as shown in the following figure , the center-to-center distance between the cylinders on the sine bar (L) is equal to 100 mm. and the height of the block gauges (H) was equal to 49.535mm. Calculate the angle A.

6/8

$L = 100 \text{ mm}$

$H = 49.535$



$$\sin \theta = \frac{H}{L}$$

$$= \frac{49.535}{100}$$

$$= \sin^{-1}(0.49535)$$

$$A = 29.6928$$

Question 6: 7 Points

A. Write three reasons why the thermocouple has been popular choice over the years.

[illegible]

① cost

② ~~It's very accuchaint~~ availability

③ It's very accuchant

[illegible]

B. Compare between the RTD and the thermistor, include the following in your answer: (resistance response to temperature change, and sensitivity)

	RTD	thermistor
resistance response	~~high~~ low	high
temep	~~[illegible]~~ leanir خطي	leanir خطي
sensitivity	~~high~~ stable	high

lainar

Question 3: 8 Points

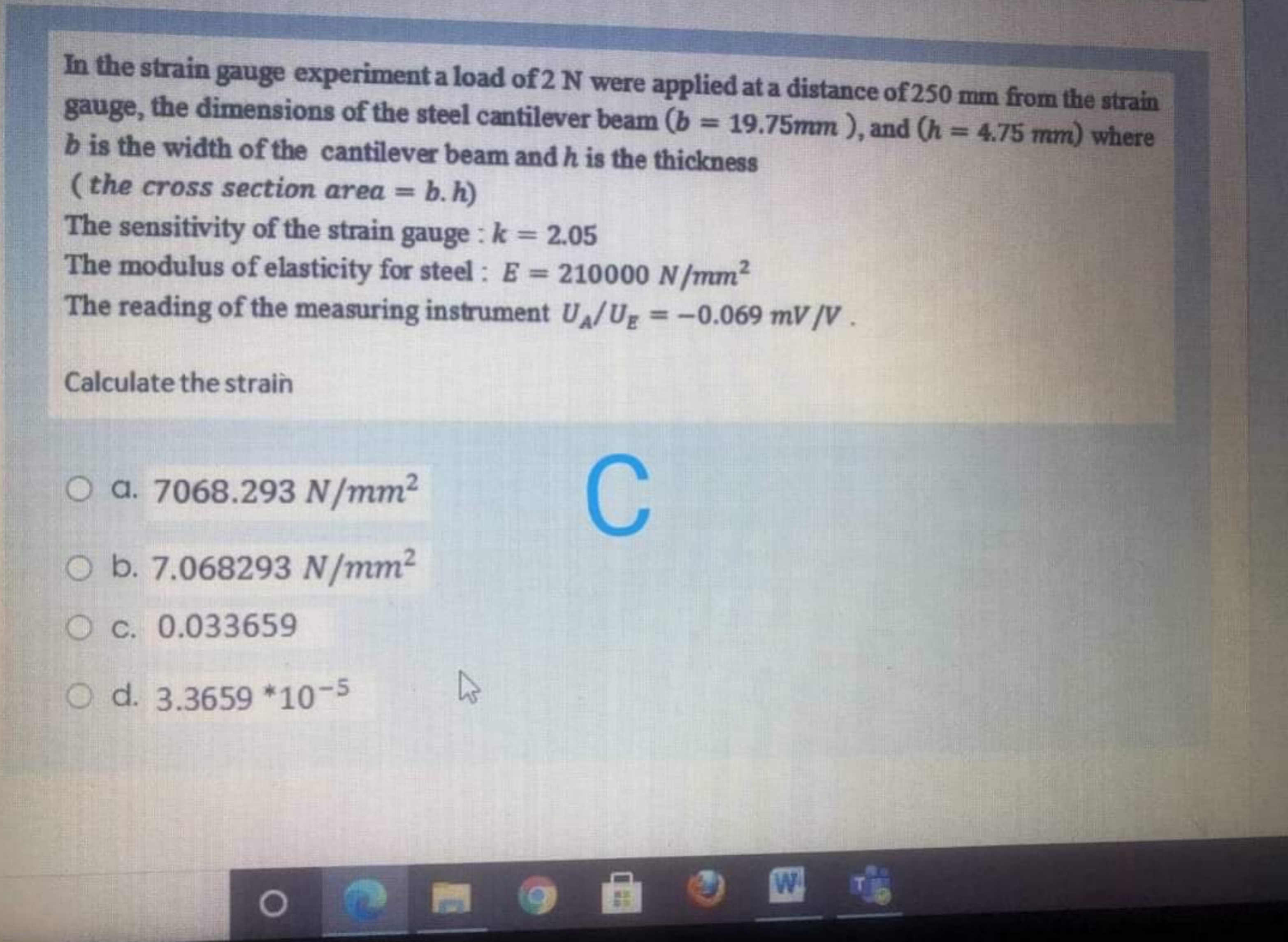
A bench micrometer was used to measure the dimensions for an external thread, the readings are given as:

The reading over the thread = 9.6320 mm
The reading over the cylinder = 9.7216 mm
The reading over the thread (with wires) = 10.0766 mm
The reading over the cylinder (with wires) = 13.2838mm
The reading over the thread (with prisms) = 11.9356 mm
The reading over the cylinder (with prisms) = 15.5464 mm

And you know that the diameter of the standard cylinder is equal to 30.0000 mm, the flank angle of the thread $(\theta) = 30^\circ$, 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
$D_{eff} = T + \frac{p}{2}\cot\theta - (\mathrm{cosec}\,\theta - 1) \cdot d$
where T is the dimension under the wire

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



In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge, the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75\ mm$) where b is the width of the cantilever beam and h is the thickness

($the\ cross\ section\ area = b.h$)

The sensitivity of the strain gauge : $k = 2.05$

The modulus of elasticity for steel : $E = 210000\ N/mm^2$

The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$.

Calculate the strain

○ a. $7068.293\ N/mm^2$

C

○ b. $7.068293\ N/mm^2$

○ c. 0.033659

○ d. $3.3659 * 10^{-5}$

Q1

1) B
2) ~~B~~D
3) A
4) A
5) A
6) C
7) C
8) B
9) A
10) A
11) A
12) B
13) A
14) B

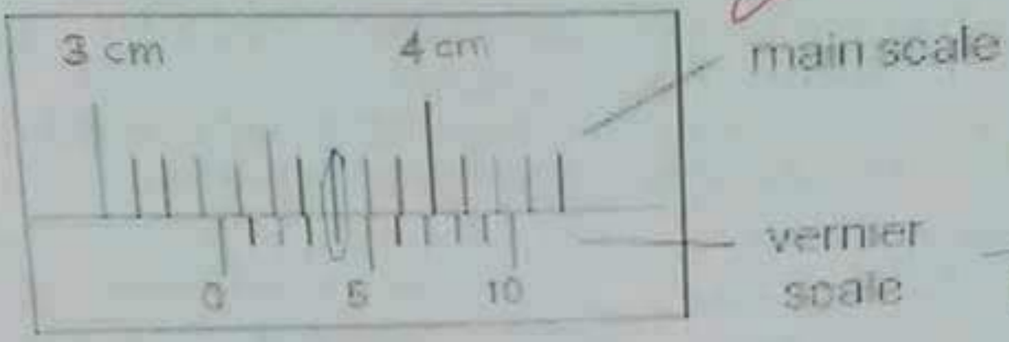
~~9) True~~
10) A

4/12

Question 2: (12 points)

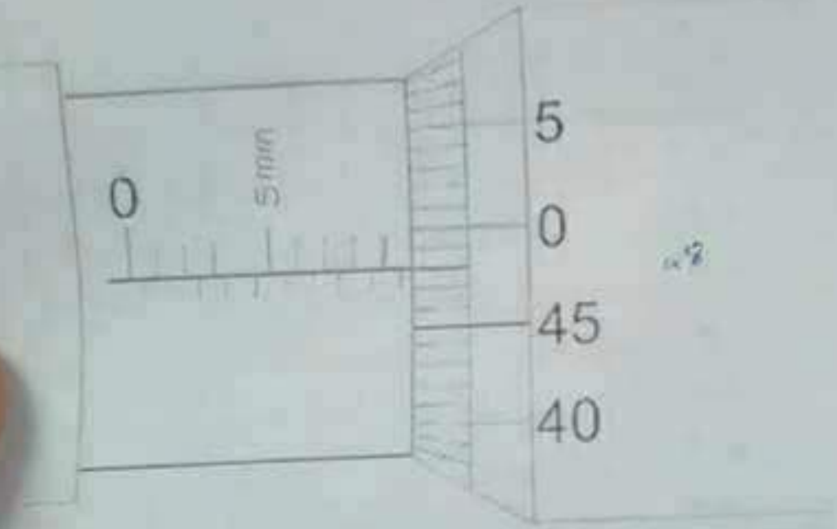
Fill in the space:

A. The reading of the following vernier caliper is 3.34 cm, and the accuracy is 0.05 mm

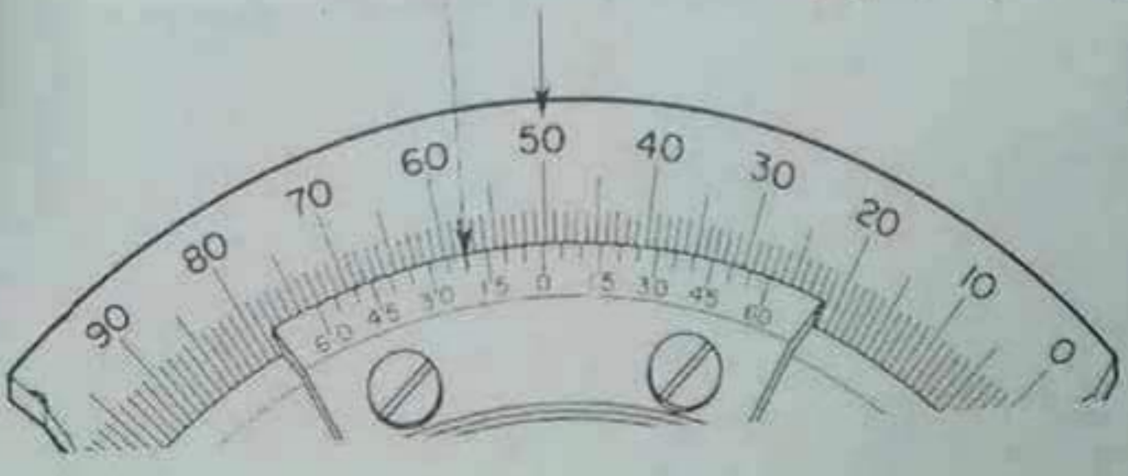

3 cm
4 cm
main scale
0
5
10
vernier scale

3.3
0.04
3.34

B. The reading of the following micrometer is 9.98 mm and the accuracy is 0.1 mm


0
5mm
5
0
45
40

C. The reading of the following vernier bevel protractor is 49° 20', and the accuracy is 0.05


90
80
70
60
50
40
30
20
10
0
60
45
30
15
0
15
30
45
60

stion 3: 5 Points

Using the root mean squared (RMS) method of surface roughness calculate the value of the surface roughness for the following ordinates obtained from testing a work piece of a length equal to 0.5 mm, where **h** are the ordinates of surfaces from mean line, and the vertical magnification factor is equal to 200000 times.

$RMS = \sqrt{\frac{\Sigma y^2}{\text{Length}}} \times \frac{1}{\text{vmf}}$

L

4/5

ordinates	h(mm)
1	0.45
2	- 0.55
3	0.65
4	0.20
5	-0.35
6	0.12
7	0.06
8	-0.12
9	-0.17
10	0.12

$$cla = \frac{h_{max} - h_{min}}{\text{Magnification}}$$

$$= \frac{0.65 - (-0.55)}{200000} = 6 \times 10^{-6}$$

$$\frac{(1.54) + -(1.25)}{5 \times 200000} = 2.9 \times 10^{-7}$$

$$\sqrt{\frac{\Sigma h^2}{n}} \times \frac{1}{m} = \sqrt{\frac{1.1657}{10}} \times \frac{1}{200000} = 1.707 \times 10^{-}$$

✓

$$\frac{0.65 + (-0.55)}{L} = \frac{0.65 - 0.55}{0.5} = 0.2$$

Question 4: 6 Points

Define the following terminology from the (thread measurement experiment)

1. major diameter $d_{major} = D (R_{th} - R_c)$

   The [illegible] outside ~~main~~ diameter

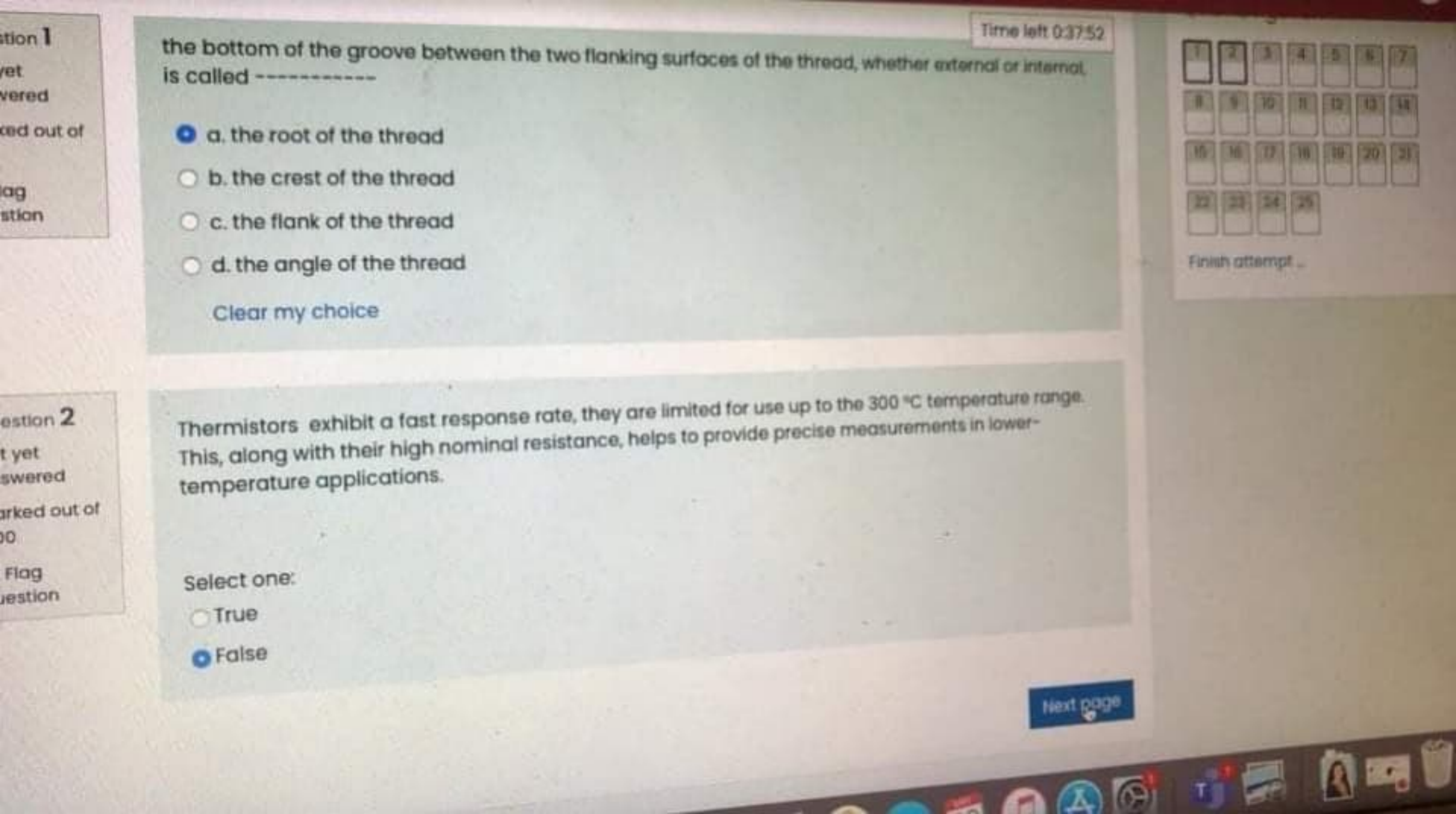
2. minor diameter $d_{minor} = D (R_{th} - R_c)$

   the inside diameter

3. crest

   the tooth of ترسي

1/6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22 23 24 25
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the bottom of the groove between the two flanking surfaces of the thread, whether external or internal, is called -----------

● a. the root of the thread

○ b. the crest of the thread

○ c. the flank of the thread

○ d. the angle of the thread

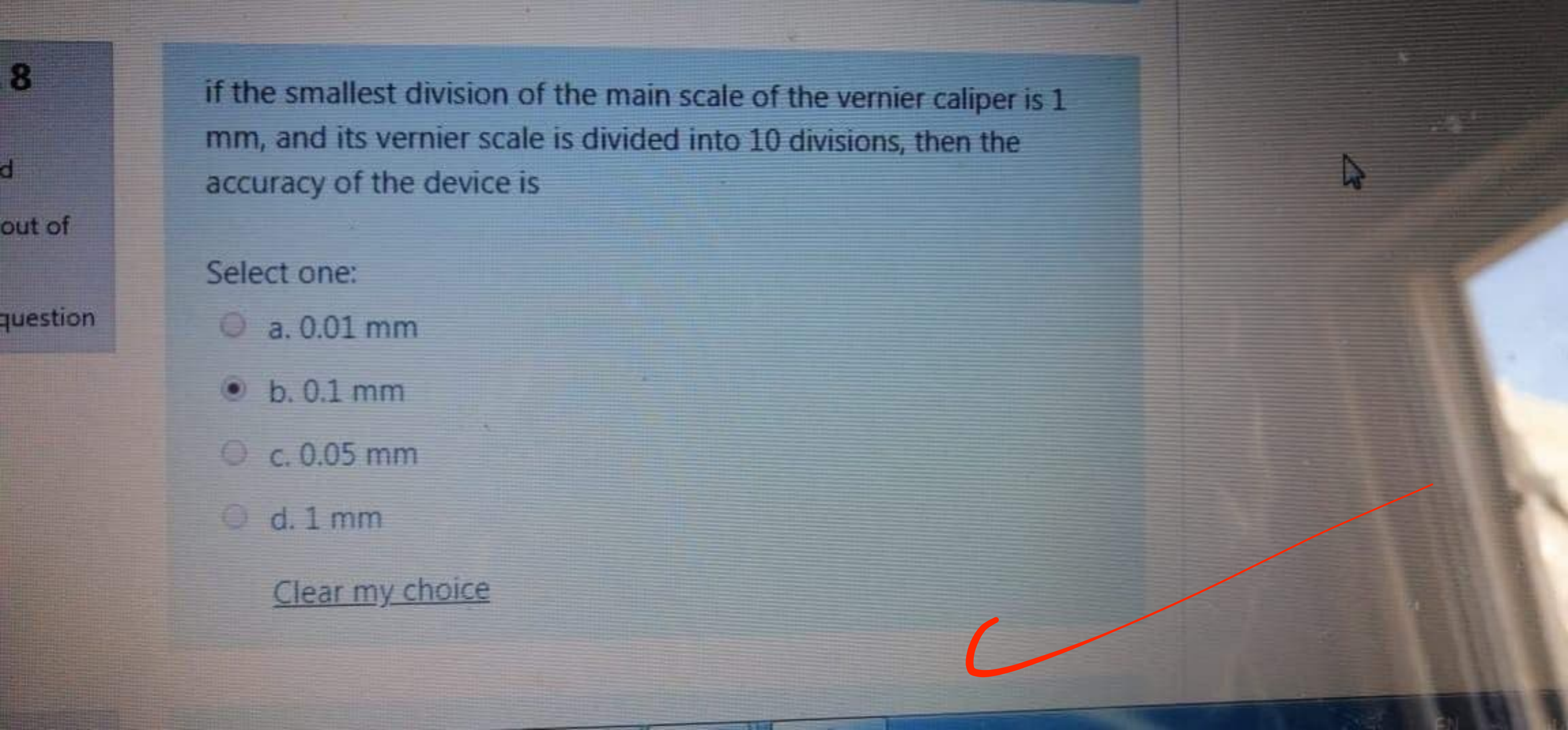
Clear my choice

Thermistors exhibit a fast response rate, they are limited for use up to the 300 °C temperature range. This, along with their high nominal resistance, helps to provide precise measurements in lower-temperature applications.

Select one:

○ True

● False



8

d

out of

question

if the smallest division of the main scale of the vernier caliper is 1 mm, and its vernier scale is divided into 10 divisions, then the accuracy of the device is

Select one:

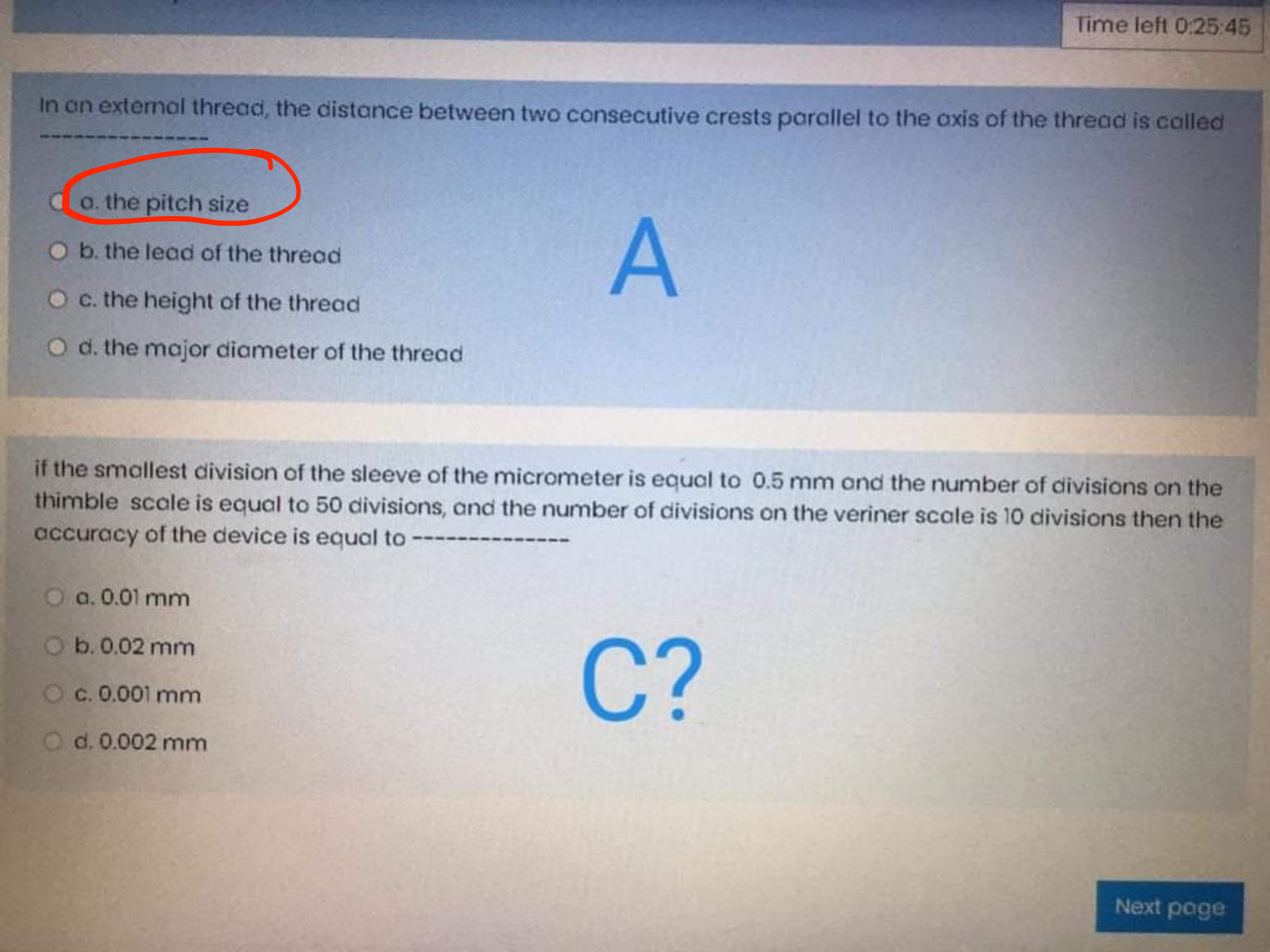
○ a. 0.01 mm

● b. 0.1 mm

○ c. 0.05 mm

○ d. 1 mm

Clear my choice



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In an external thread, the distance between two consecutive crests parallel to the axis of the thread is called ----------------

○ [✓ a. the pitch size]

○ b. the lead of the thread

○ c. the height of the thread

○ d. the major diameter of the thread

A

if the smallest division of the sleeve of the micrometer is equal to 0.5 mm and the number of divisions on the thimble scale is equal to 50 divisions, and the number of divisions on the veriner scale is 10 divisions then the accuracy of the device is equal to --------------

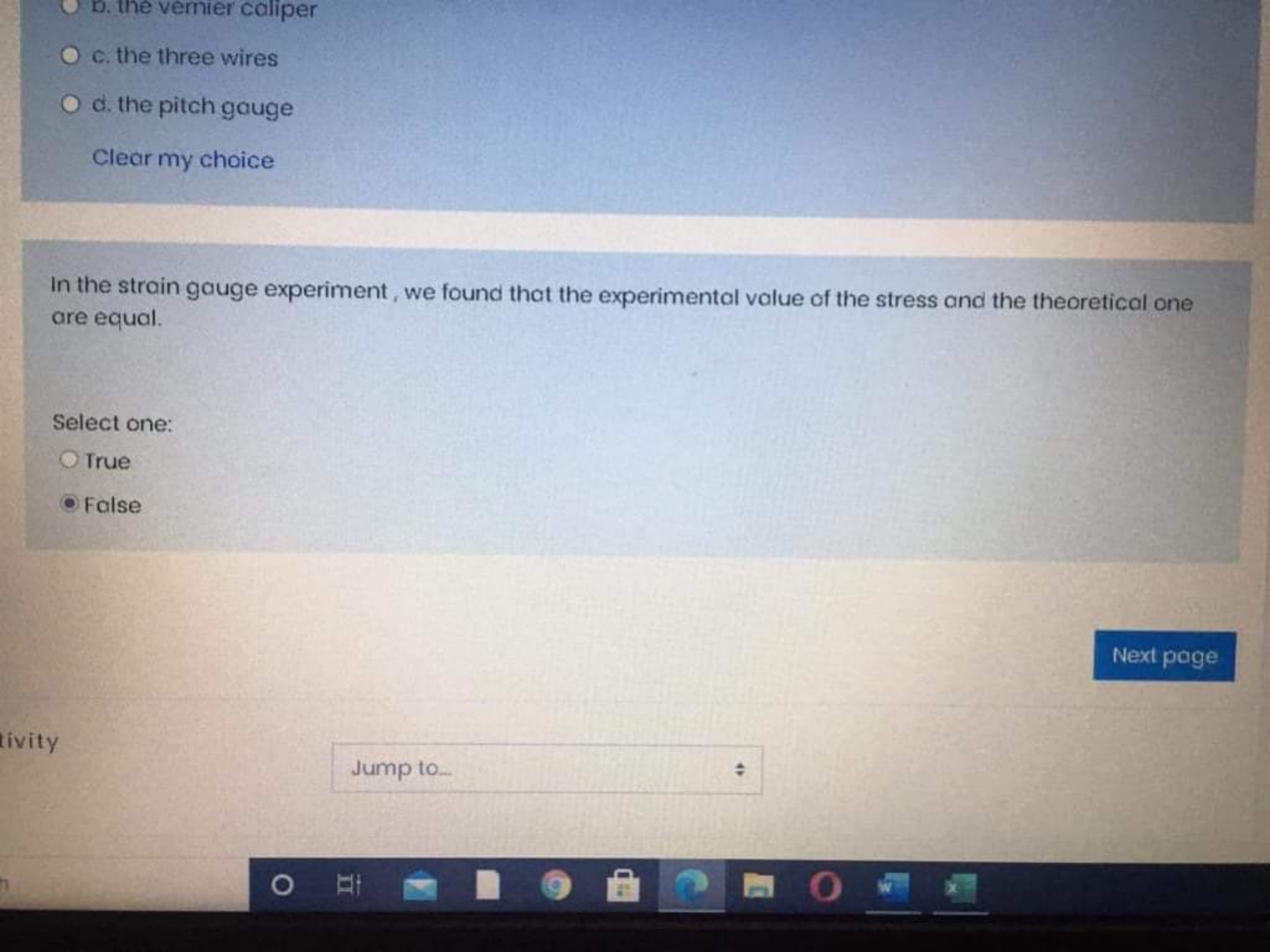
○ a. 0.01 mm

○ b. 0.02 mm

○ c. 0.001 mm

○ d. 0.002 mm

C?



○ b. the vernier caliper

○ c. the three wires

○ d. the pitch gauge

Clear my choice

In the strain gauge experiment , we found that the experimental value of the stress and the theoretical one are equal.

Select one:

○ True

● False

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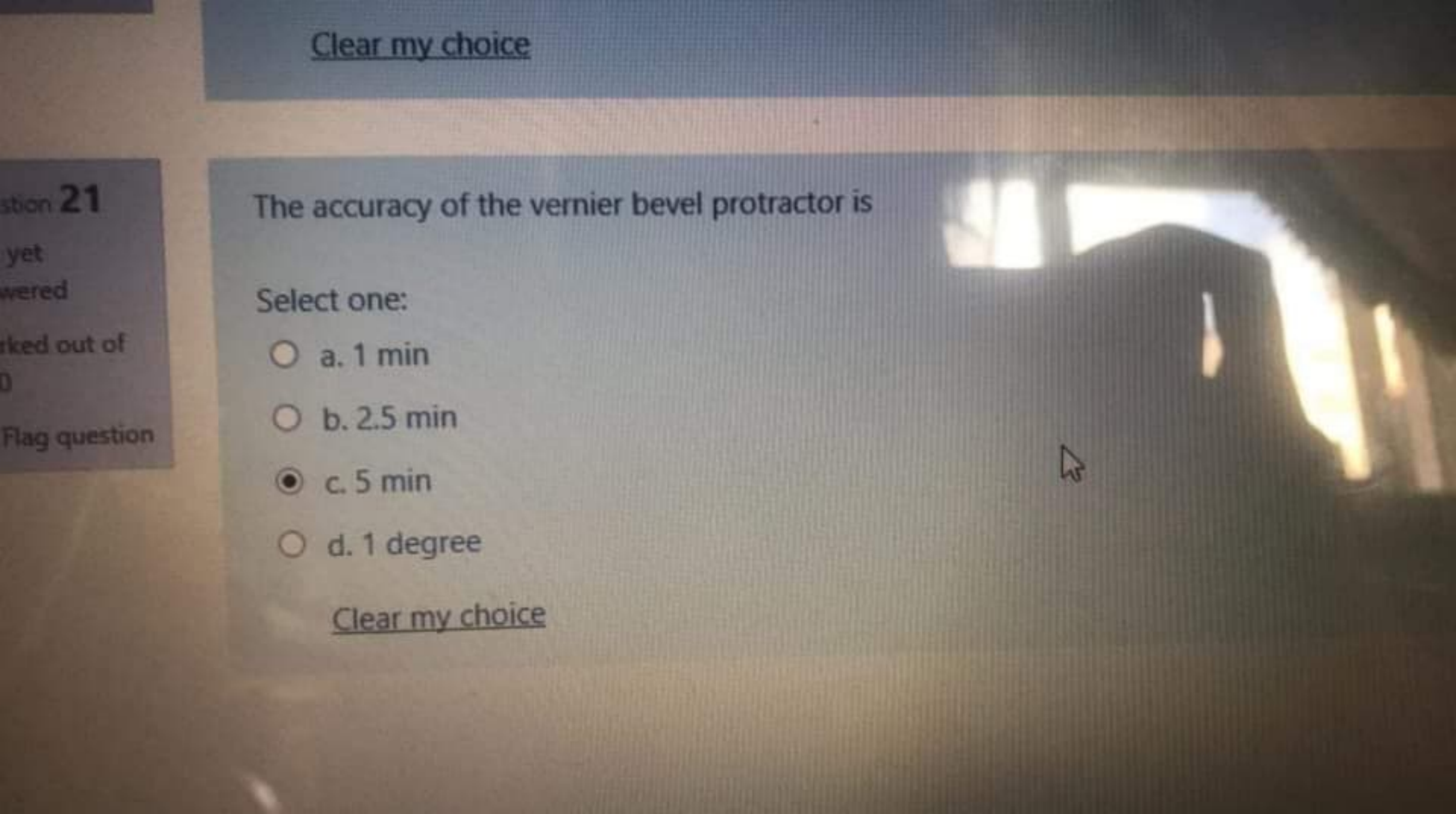

Clear my choice

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Flag question

The accuracy of the vernier bevel protractor is

Select one:

○ a. 1 min

○ b. 2.5 min

● c. 5 min

○ d. 1 degree

Clear my choice

Question 2: (14 points)

A. Describe with a simple sketch the working principle of the autocollimator. (6 points)

It is instrument that autocollimator send beam collimated = parallel light, an external reflector reflect all or part of the light to an instrument that focused the light with [illegible] reflector

The autocollimator calculate the deviation between the transmitted light and reflected to see the difference, Because the autocollimator use light there is no contact with the surface So the dust doesn't affect on it, is sensitive measurement.

4/6

B. Describe the working principle of the clinometers (4 points)

4/4

Clinometer is device to measure the included angle between two surfaces that we put the clinometer on one of the surfaces and check if the bubble is in zero level, if not, we [illegible] to [illegible] the bubble then take the reading, repeat it on the second surface and then calculate the difference between the readings.

C. Does the external micrometer obeys to the Abbe's Princilpe? Explain (4 points)

yes

2/4

Question 3: (4 points)

A. Using the following set of gauge blocks, list the minimum number of blocks to produce an overall dimension of 76.575 mm. (show your calculations)

Metric (103) pieces	
	Increment
1 piece (1.005) mm	
49 pieces (1.01 to 1.49) mm	0.01
49 pieces (0.5 to 24.5) mm	0.5
4 pieces (25- 100) mm	25

2/2

76.575
(1) - 1.005
75.57
(2) - 1.07
74.5
(3) - 24.5
50.0
(4) - 50.0
0.0

B. Write two applications of block gauges.

1/2

1) In industry to make a standard [illegible]

2) In any accurate measurement.

Final exam
Measurement lab (0906442)

Eng. Lamees Al-Durghan
may, 8,2018

Student name: ______________________ Student no.______________________ Section ______

Question 1:

Select the best answer for each of the following paragraph: 18 Points

1. What device is similar to an RTD but has a negative temperature coefficient?
A. Strain gauge
B. Thermistor
C. Negative-type RTD
D. Thermocouple

2. Temperature sensing can be achieved by the use of
A. Thermocouples
B. RTDs
C. Thermistors
D. All of the above

3. The output voltage of a typical thermocouple is
A. less than 100 mV
B. greater than 1 V
C. Thermocouples vary resistance, not voltage
D. None of the above

4. The connections to a thermocouple:
A. can produce an unwanted thermocouple effect, which must be compensated for
B. produce an extra desirable thermocouple effect
C. must be protected, since high voltages are present
D. both B and C are correct

5. The purpose of compensation for a thermocouple is
A. to cancel unwanted voltage output of a thermocouple
B. to decrease temperature sensitivity
C. to increase voltage output
D. used for high-temperature circuits

6. The strain gauge resistance varies with:
A. Vibration
B. Heat
C. Weight
D. Bending

7. RTD stands for
A. Relative Thermal Devices
B. Radioactive Thermonuclear Dipoles
C. Resistance Temperature Detectors
D. Resistive Temperature Devices

8. The decrease of resistance with the temperature increase is a property of:
A. Thermocouple
B. bimetallic thermometer
C. Thermistor
D. RTD

Final exam
Measurement lab (0906442)

Eng. Lamees Al-Durgham
may, 8,2018

Student name: ________________ Student no: ________________ Section ______

Question 1: (8 Points)

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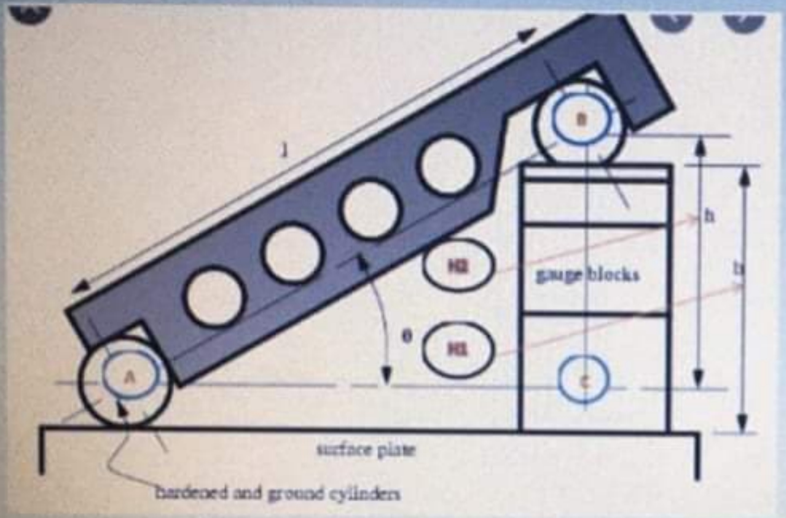
C. Thermistor
D. RTD

If the length of the sine bar (L = 100 mm), and the height of the gauge blocks (h=50 mm), then the angle theta is equal to ------------------


L
B
H2
gauge blocks
h
h1
θ
H1
A
C
surface plate
hardened and ground cylinders

○ a. 30 degree

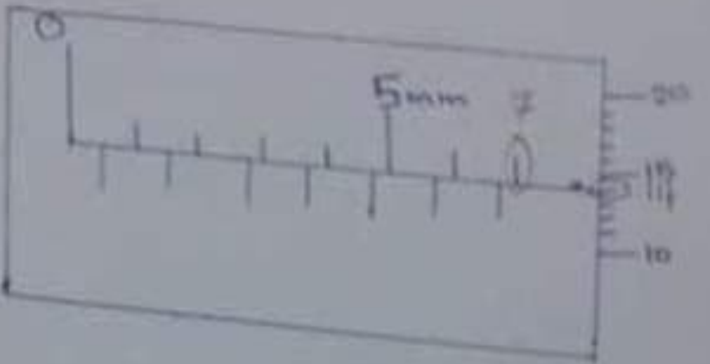
○ b. 45 degree

○ c. 60 degree

○ d. none of the above is correct

30

علامات ٣ (٢)



$\Rightarrow$ 7.14 mm

علامتين (٣)

What size is the gage block build-up used with a 10 inches sine bar to set the work piece at an angle of 4° 30′ ? show your calculations

$\sin\theta = \frac{h}{L} \Rightarrow \boxed{h = \sin\theta \times L}$

السؤال الثالث ← ٦ علامات

Describe the working principle of the Auto Collimator?

The Auto Collimator is an optical device used to measure small angles with very high sensitivity. The Auto Collimator projects a beam of collimated light. An external reflector reflects all or part of the beam back into the instrument where the beam is focused and detected by a photodetector

3

the Auto Collimator measures the deviation between the

uestion 2

8 po

surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

Position	Autocollimator reading	Difference from first reading	Rise or fall over 100 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	sec	micrometer	micrometer		
0		0	0	0	0	
0 -50	8	0	0	0	1	
50-100	10	2	0.5	0.5	2	
100-150	18	10	2.5	3	3	
150-200	22	14	3.5	6.5	4	
200-250	24	16	4	10.5	5	
250-300	14	6	1.5	12	6	
300-350	10	2	0.5	12.5	7	
350-400	16	8	2	14.5	8	
400-450	18	10	2.5	17	9	
450-500	20	12	3	20	10	

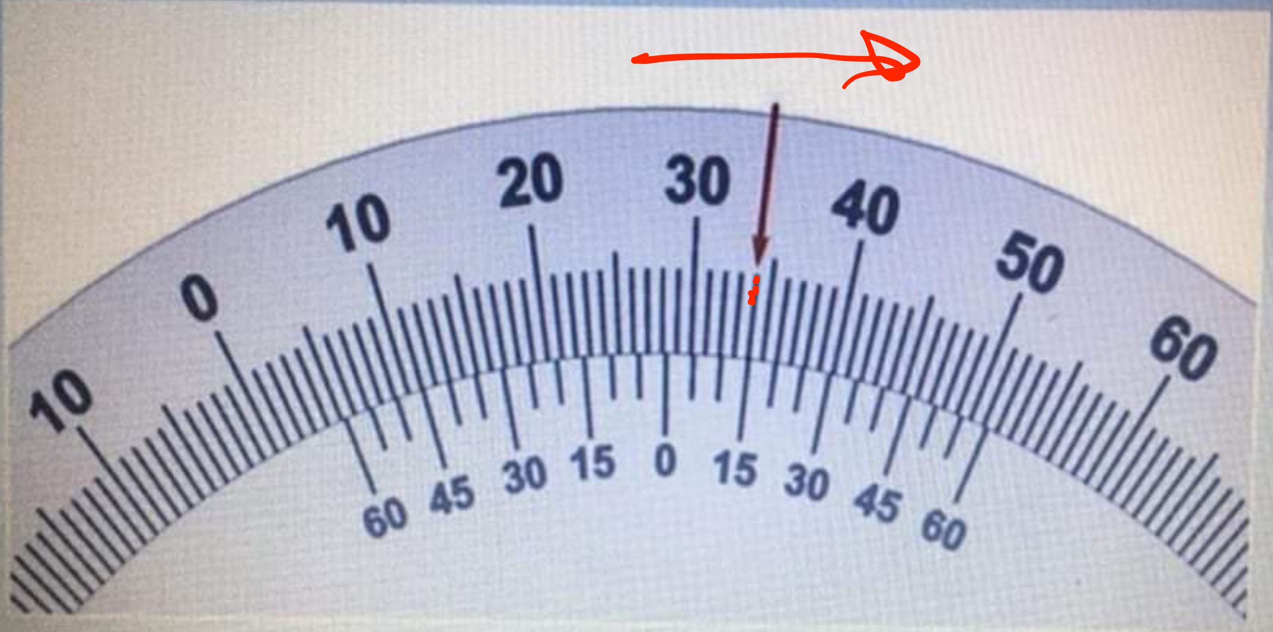
m = [illegible] = 12.7 $\bar{y} = 1.8181$

$C = \bar{y} - m\bar{x}$

$= 1.8181 - 250 \times 12.7$

$= -3173.1817$

The reading of the vernier bevel protractor is



10
0
10
20
30
40
50
60
60 45 30 15 0 15 30 45 60

○ a. 28 degrees and 34 minutes

○ b. 28 degrees and 15 minutes

○ c. 34 degrees and 15 minutes ✓

○ d. 15 degrees and 34 minutes

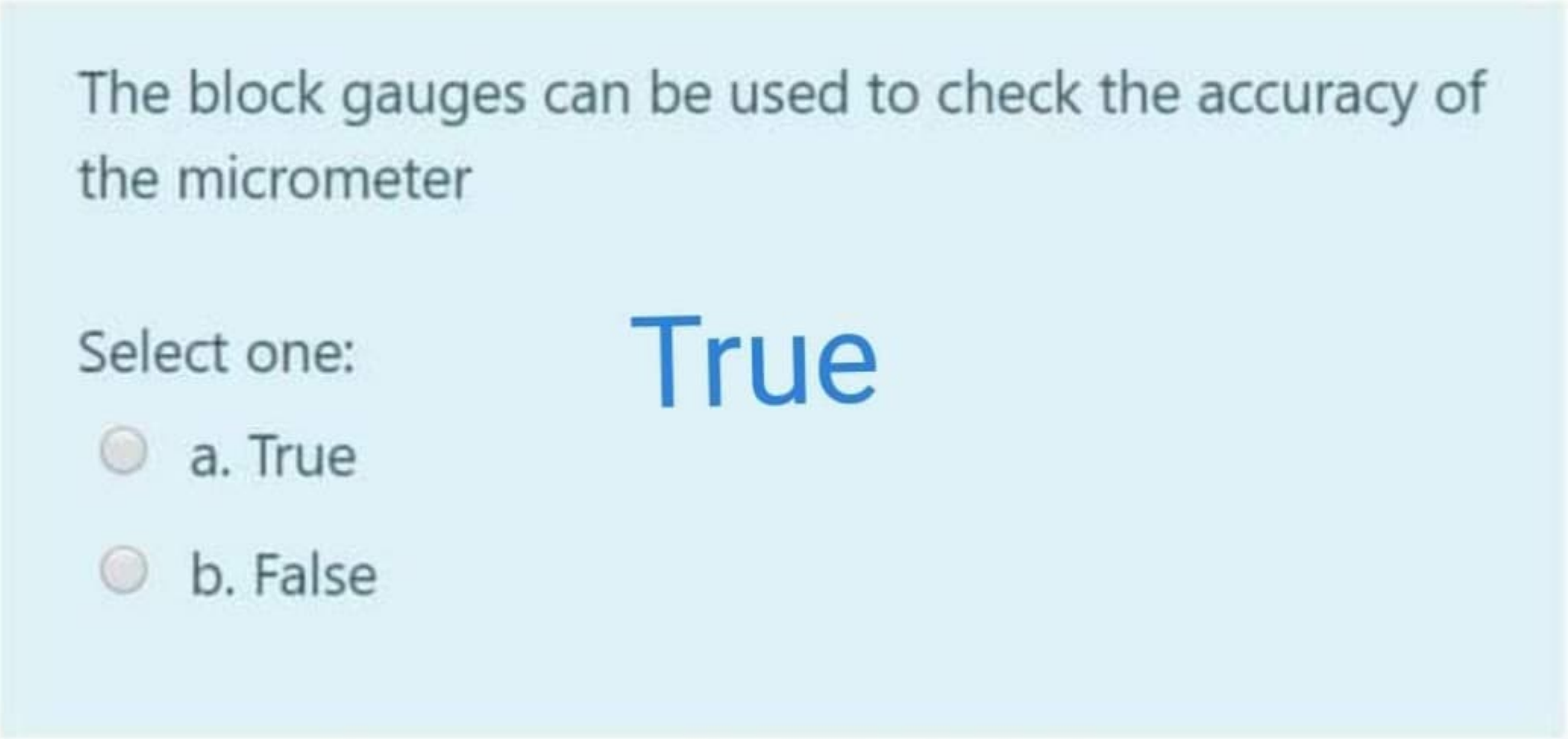
B

Question 4:

8 Points

In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge , the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75$ mm)
where b is the width of the cantilever beam and h is the thickness
(*the cross section area* $= b.h$)
The sensitivity of the strain gauge : $k = 2.05$
The modulus of elasticity for steel : $E = 210000\ N/mm^2$
The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$.

A. Calculate the strain(ε), the experimental value of the stress (σ), and the theoretical value of the stress (σ).
B. Comment on the results of the stress you calculated in A.



The block gauges can be used to check the accuracy of the micrometer

Select one:

True

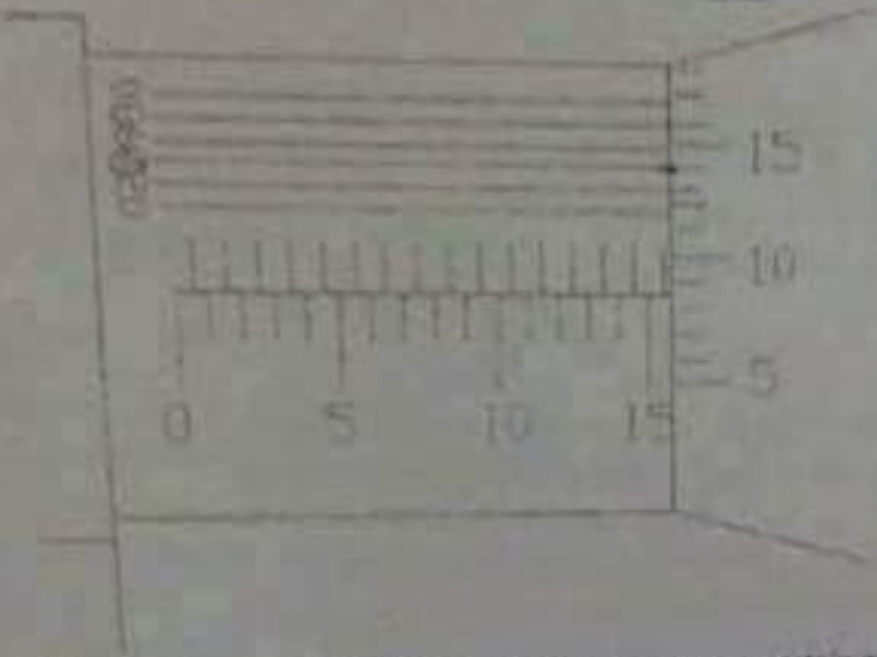
○ a. True

○ b. False

16 Points

A student used a vernier micrometer to measure a certain dimension. The diagram shows an enlargement of the micrometer scales. What reading was recorded?

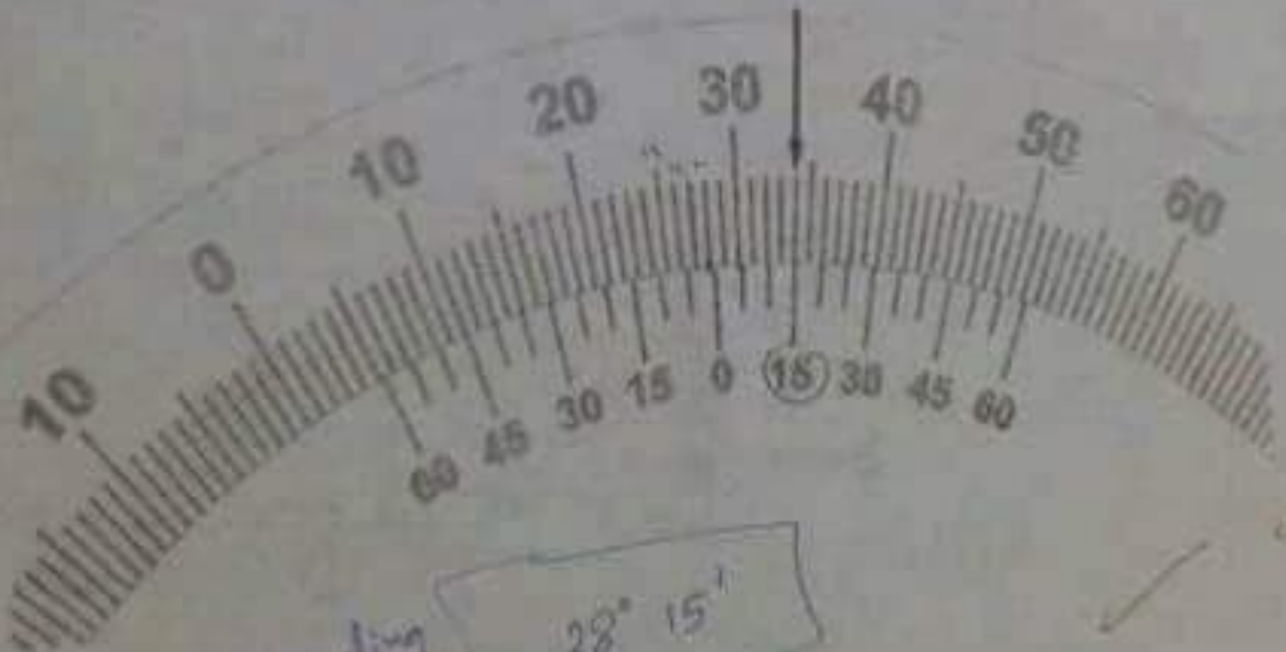
Note: the dimensions on the sleeve are in mm.


15
10
5
0
5
10
15

16.34 mm = 163.4 mm

1
15.50 +
0.80
0.04
16.34

B. A student used a vernier bevel protractor to measure a certain angle. The diagram below shows the reading of the angle. What reading was recorded?


10
0
10
20
30
40
50
60
60
45
30
15
0
15
30
45
60

The reading of the angle is

28° 15'

4