re temperature with the thermistor, you only need to mea
hermistor, and then substitute the resistance value in the f

$$T = \frac{1}{a + b(\ln R) + c(\ln R)^3}$$

Calculated temperature in (K)
Measured resistance in (Ω)
and c are Steinhart-Hart Constants that have the followi
*1.2407635*10^{-3}*
*2.3612017*10^{-4}*
*8.97975*10^{-8}*

ation you will get the temperature in Kelvin. The value
e of to another.

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

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

because accuracy Reading and standard measurments & calibrabion

6/6

Question 4: (6 points)

Describe the working principle of the clinometer

Clominitor its device using for angular measurments how face aligned for each other put the clominaor on face check the reading of Bubble equal zero if not you have more knop and reverstal until the Babble gives zero reading clominaator consist of two scale main scale in degree vernier scale The reading in second by reverse worR pices after that add all resar to set the movements of all alligned measure angle

emitted beam and the reflected beam because the Auto collimator uses light to measure angles so it never comes into contact with the test surface.

السؤال الرابع :- ١٥ علامة

Study the profile in the figure then answer the following questions:

a. Find the center line

b. Calculate the surface roughness using:

1. Maximum peak to valley height method
2. ten points height method
3. Root mean square method

where the actual length of the specimen is equal to 10 mm and the vertical magnification is equal to 500 000.

نفس الرسمة إلي أخدتوها بالـلاب
بتكون موجودة بالسؤال

Error of the form -

Secondary texture

primary texture

As ℓ increases, the roughness increases -

Note: it doesn't matter where we choose the reference line. "Peak to valley"

① Peak to valley

$R_a = \frac{y_1 - y_2}{VMF}$

Drawback ~~Disadvantages~~ - we only considered two points to calculate roughness → inaccurate.

② 10 points height of irregularities:

5 peaks and 5 valleys

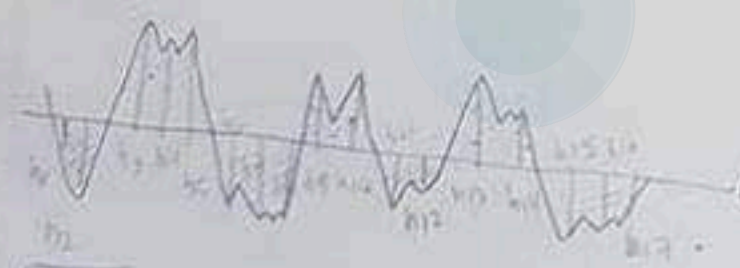
peaks o dc $\hat{}$

valleys o dc $\hat{}$,

$R_z = \frac{(Y_1+Y_3+Y_5+Y_7+Y_9) - (Y_2+Y_4+Y_6+Y_8+Y_{10})}{5 * VMF}$

③ h_{RMS} (Root Mean Square) value:-

Area above CL - Area below it



$\sqrt{\frac{\Sigma h^2}{n}} * \frac{1}{VMF}$

عدد النقاط

④ CLA method.

to self-heating.

Theory:

RTDs are commonly categorized by their nominal resistance at 0 °C. Typical no resistance values for platinum thin-film RTDs include 100 and 1000 Ω. In TMT a P RTD is used.

In order to measure temperature with the RTD, you only need to measure the resi of the RTD, and then substitute the resistance value in the following equation

$$T = \frac{R_o - R}{-0.5(R_o A + \sqrt{R_o^2 A^2 - 4R_o B(R_o - R)})}$$

Where:

T : Calculated temperature in (°C).
R_o : RTD nominal resistance at 0 °C, R_o=100 Ω.
R : Measured resistance (Ω).
$A = 3.90802 \times 10^{-3}$
$B = -5.80195 \times 10^{-7}$

bove equation will give you the temperature in °C. The value of R_o, A & B di one type of RTD to another.

9/10

NO. EXP (5)

"screw thread"

$R_{th} = 10.8898$
$R_{cy} = 11.0444$

$R_{th\,prism} = 15.8858$
$R_{cy\,prism} = 20.5426$

$R_{th\,wires} = 11.7268$
$R_{cy\,wires} = 15.0482$

يزن سليمان السيد 0155005
ناصر اسد قاسم 0153876
ابراهيم ابوفارس 0156598
محمد احمد طلبه 0144875
محمود الويات 0144832

$D_{cy} = 30\,mm$
$d = 2.0207\,mm$
$P = 3.5\,mm$
$\theta = 30°$

* Major diameter $= D_{cy} + (R - R_{cy})$
$= 30 + (10.8898 - 11.0444) =$ **29.8454**

* Minor diameter $= D_{cy} + (R_{th} - R_{cy})$
$= 30 + (15.8858 - 20.5426) =$ **25.3432**

* Effective diameter $= T + 2x$

- $2x = \frac{P}{2}\cot\theta - [\mathrm{cosec}\,\theta - 1]\,d$
- $T = D + (R_{th} - R)$

$2x = \frac{3.5}{2}\cos(30) - [\mathrm{cosec}(30) - 1] \times 2.0207 =$ **1.01038**

$T = 30 + (11.7268 - 15.0482) =$ **26.6786**

effective diameter $= T + 2x = 1.01038 + 26.6786 =$ **27.68898**

FIVE APPLE

Does the external micrometer obeys Abbé's principle?

es, ~~Max~~ accuracy may ~~ob~~obtain ~~when~~ the ~~stand~~ scale & the work piece ~~part~~ measured are aligned on the same line (measurment). because the standard scale & the wp are aligned

---

Q2) Does the caliper conform abbe's principle?

NO, as we carried out the measurment procedure we can't allign the scale & the wp

---

Q3) errors in reading caliper:?

human error, zero error, allignment error

Q4) vernier → line standards

gauge block → end stand

Q5) vernier > micrometer → measure both thickness, inside diam & depth

Design of strain gauge

Component

Backing film

Bending experiment

t Fundamentals

e stress at the surface of the bending beam can be calculated from the bending moment M
e section modulus Wy

$$\sigma = \frac{M_b}{W_y}$$

ending moment calculated for cantilever beam

$$M_b = -F \cdot L$$

here F is the load and L the distance between the point at which the load is introduced a
easurement point. The section modulus for the rectangular cross section of width b and h

$$W_y = \frac{b h^2}{6}$$

For experimental determination of the bending stresses, the bending beam is provided w
train gauges each on the compression and tension sides. The strain gauges of each s
ranged diagonally in the bridge circuit. This leads to summation of all changes in resistan
high level of sensitivity. The output signal UA of the measuring bridge is referenced to t
oltage UE. The sensitivity k of the strain gauge enables the strain ε to be calculated for
ridge as follows

$$\varepsilon = \frac{1}{k} \cdot \frac{U_A}{U_E}$$

According to Hooke's law the stress being sought is obtained with the modulus of ela
(Modulus of elasticity for steel: 210000 N/mm2)

$$\sigma = \varepsilon \cdot E$$

Position	Autocollimator Mean Reading	Difference from first reading	Rise or fall over 50mm baselength	Cumulative Rise or Fall	Adjustment required	Error
mm	seconds	seconds	μm	μm	μm	μm
0			0	0	0	0
0-50	20	0	0	0	1	1
50-100	18	-2	-0.5	-0.5	2	1.5
100-150	16	-4	-1	-1.5	3	1.5
150-200	10	-10	-2.5	-4	4	0
200-250	14	-6	-1.5	-5.5	5	-0.5
250-300	24	4	1	-4.5	6	1.5
300-350	22	2	0.5	-4	7	3
350-400	18	-2	-0.5	-4.5	8	3.5
400-450	10	-10	-2.5	-7	9	2
450-500	8	-12	-3	-10	10	0

3. The cumulative rise or fall column, gives the amount by which the end of each segment is displaced from zero datum line AB. When these values are plotted, the graph obtained is shown in Figure 5.

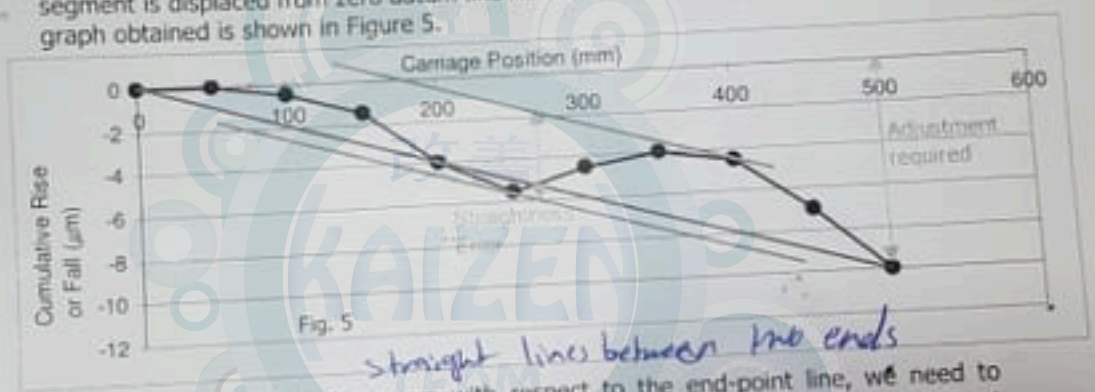


Fig. 5

4. In order to determine the errors with respect to the end-point line, we need to rotate the right end so that the error there becomes zero. Thus, the adjustment required at the last point is negative of the cumulative rise or fall at that point. This total adjustment has to be reduced proportionate to the distance from the first point to get the required adjustments at the intermediate points. The adjustment at the first point will be zero.
5. Add the adjustment required at each point to the cumulative rise or fall. The straightness error along the line is the maximum error – minimum error= (3.5-(-0.5))=4.0 in this case. See Fig. 5.

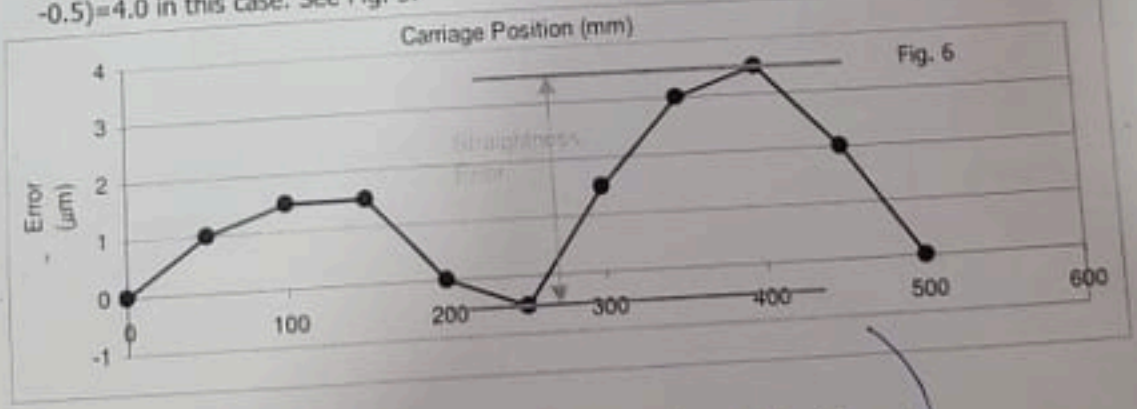


Fig. 6

state the diff b/w end standard & line standard & why end standard more accurate
↳ [Gauge block]

ans) in line stand, the unit length is defined as being the distance suitably engraved lines, while in end stand, unit of length is defined as being the distance b/w the end faces of the stand.
end stand is more accurate because the whole piece can measure 5mm for en ~~white line only + cm of 1.5m~~

Q.) Why we choose the min number of block combination?

ans) to have the least error & for accurat reading

end stand measurment & calibration
↳ high accuracy
↳ have a built in datum becuz their measuring faces are flat & parrallel

---

Gauge characteristic :-

1) straightness
2) flatnes
3) parrallelism

Qu) diff b/w different grades of blocks :-

when the grades get larger the tolerance get larger & price checaber → most expensive grade 00

Q3) what is the accuracy of gage block

the accuracy is 0.0005 mm depend on the smallest division measure

* use peak to valley method :- $\frac{6.3 - (-6.1)}{100000} = 1.24 \times 10^{-4}$

* use 10 point method :- $\frac{(3.4 + 6.3 + 5.3 + 4 + 3.3) + (6.1 + 3 + 4.5 + 5.6 + 3.1)}{500000} = 8.92 \times 10^{-5}$

* use root mean square :- $\sqrt{\frac{\sum h^2}{n}} \propto \frac{1}{\sqrt{uf}} = \sqrt{\frac{3.4^2 + 5.3^2 + 4.9^2 + 1^2 + 1.6^2 + 6.1^2 + 3.5^2 + 1.7^2}{n}} \propto \frac{1}{100000} = 3.47 \times 10^{-5}$

* CLA :- $\frac{\text{area above + area below}}{\text{length}} \propto \frac{1}{\sqrt{uf}} = \frac{3.4 + 6.1 + 2.8 + 1.65 + 6.3 + 2.4 + 4.24 + 1.125 + 2.4 + 5.32 + 1.485}{15.1 \times 100000}$

$= 2.498013245 \times 10^{-5}$

8/10

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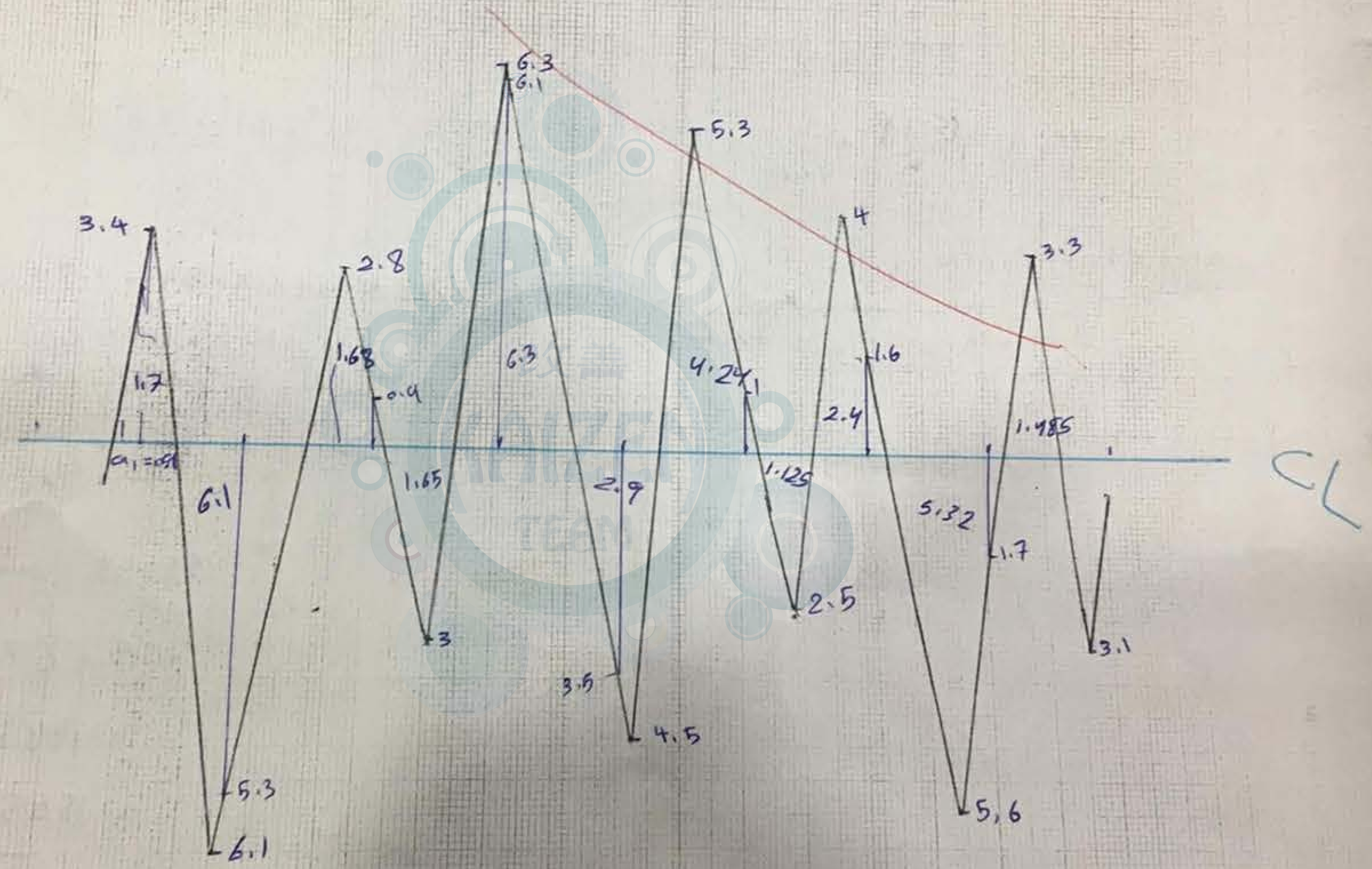
محمد الديا = 0144832

$(3.4 + 6.3 + 5.3 + 4 + 3.3) - (-6.1 + -3 + -4.5$



Question 2:

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

clinometer , It's device using for angler measurment o how to face aligned from each other ; put the clinometer on one face check the reading of Bubbles equel zero if not you have to move knope and reversal until the Bubbles give zero reading . clinometer consist of two scale main scale in degree , veriveer scale in minute you can get the reading in secoued by reverse work piece after that add all reading to get the account of alignd measure of angle

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 increase in angle observed corresponds to a rise of 0.25 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 points (0–50). (4 points)

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

	Position	Autocollimator reading	Difference from first reading	Rise of fall over 50 mm	Cumulative rise or fall			x_m $(x-\bar{x})$	y_m $(y-\bar{y})$	$x_m x_m$	$y_m x_m$
	Mm	Sec	sec	micron	micron						
	0	0	0	0	0	0		-250	-3.7	925	-0.37
1	0 -50	22	0	0	0	1	1	-200	-3.7	740	-1.22
2	50-100	20	-2	-0.5	-0.5	2	1.5	-150	-4.2	630	-3.07
3	100-150	18	-4	-1	-1.5	3	1.5	-100	-5.2	520	-2.92
4	150-200	12	-10	-2.5	-4	4	0	-50	-7.7	385	-3.77
5	200-250	16	-6	-1.5	-5.5	5	-0.5	0	-9.2	0	-4.62
6	250-300	26	4	1	-4.5	6	1.5	50	-8.2	-410	-5.47
7	300-350	24	2	0.5	-4	7	3	100	-7.7	-770	-6.32
8	350-400	20	-2	-0.5	-4.5	8	3.5	150	-8.2	-1230	-7.17
9	400-450	12	-10	-2.5	-7	9	2	200	-10.7	-2140	-8.2
10	450-500	10	-12	-3	-10	10	0	250	-11.7	-2925	

250 graphical method $\bar{y}$ -3.77

$$m = \frac{\sum y_m x_m}{x_m^2} = \frac{-4775}{275000} = -0.017$$

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

$$c = -3.77 - (-0.017 * 250)$$

$$c = 0.48$$

$$y = -0.017x + 0.48$$

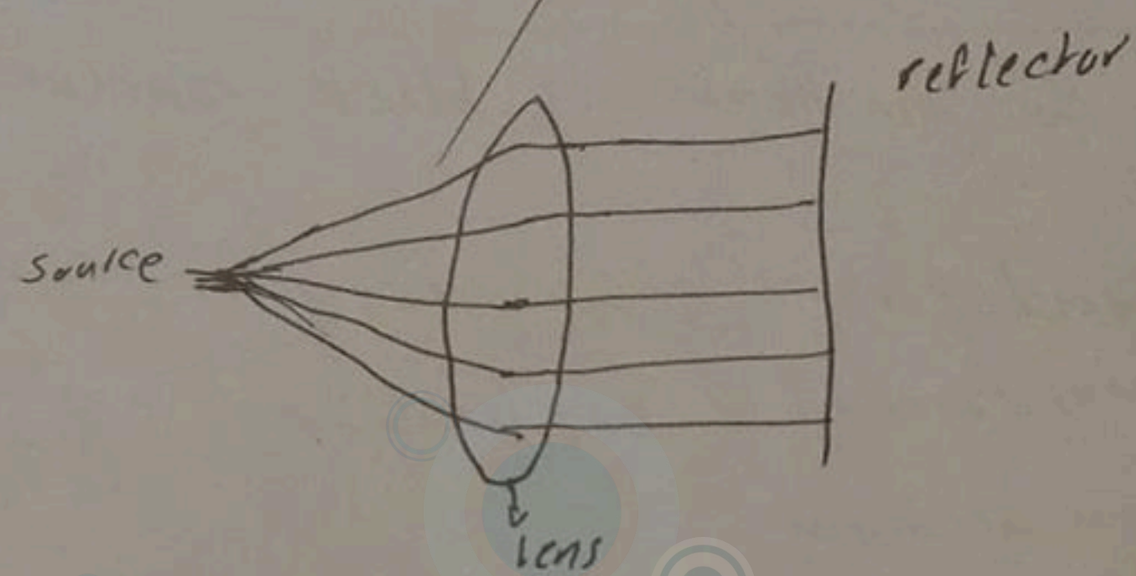
Straight line $= -1.88 - -5.5 = 3.62$ Mm

error

4.18
-4.07
-2.48
-1.13
-4.78
-5.43
-3.58
-2.23
-1.88
-3.5
-

1) Describe the working principle of the Auto collimator?

the Auto collimator is an optical device used to measure small angles with very high sensitivity. it projects a beam of collimator light An external reflector reflects all or part of the beam back into the instrument where the beam focused & detected by a photo ~~dector~~ detector it measures the deviation b/w emitted beam & the reflected beam because the Auto colli uses light to measure angles, it never comes into contact with the test surface



Describe the working principle of the clinometer? measure of included angle of 2 adjacent faces

ans) its a device using for angular measurment, how to ~~of~~ wp

1) face aligned for each other, put the colominar on ~~face~~ one face
2) check the reading of bubbles equal zero if not ~~that's means that~~ you have move knope & ~~reverse~~ revental until the bubbles give zero reading. / the included angle b/w the faces being the difference the 1 & 2 read

clinometer consist of two scale ~~main~~, main scale in degree, other scale in minutes, you can get the reading in second by reverse work piece after that add all reading to set the measurment of all aligned angle

4) write two ~~fun~~ application of gage block :-

1) Provide a reference for direct measurment of distances b/w parallel surf
2) used in Angular measurment such as sine bar