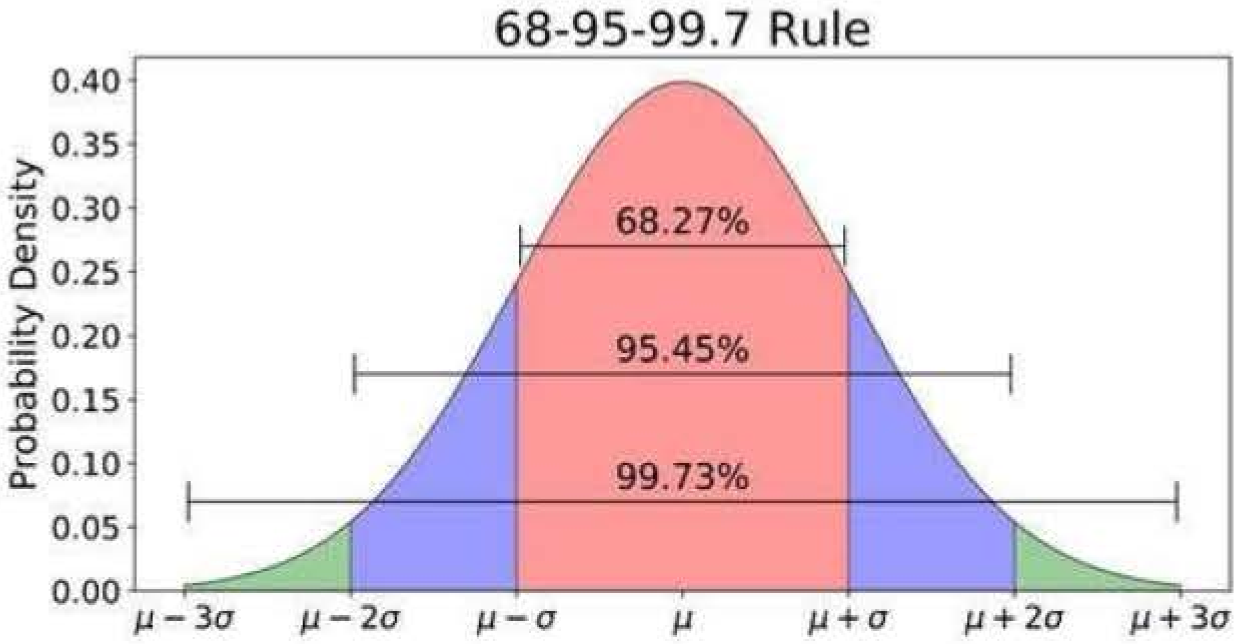
1. Determine the 50% error for the distance measurements: 145.62 measured two times, 145.79 measured one time, 145. 76 measured three times, 145.58 measured one time, and 145.54 measured two times. Indicate the most probable value, minimum probable value, and maximum probable value with this confidence level.

Error (=)	Probability (%)	Probability that error is larger than value
0.50σ	38.3	≈ 2 in 3
0.6745σ	50.0	1 in 2
1.00σ	68.3 ✓	1 in 3
1.6449σ	90.0	1 in 10
1.9599σ	95.0	1 in 20
2.00σ	95.4	1 in 23
3.00σ	99.7	1 in 333
3.29σ	99.9	1 in 1000



x	Freq.
145.62	2
145.79	1
145.76	3
145.58	1
145.54	2

STAT LINE
$\bar{x}$
145.6633333

STAT LINE
$x\sigma n$-1
0.1031988372

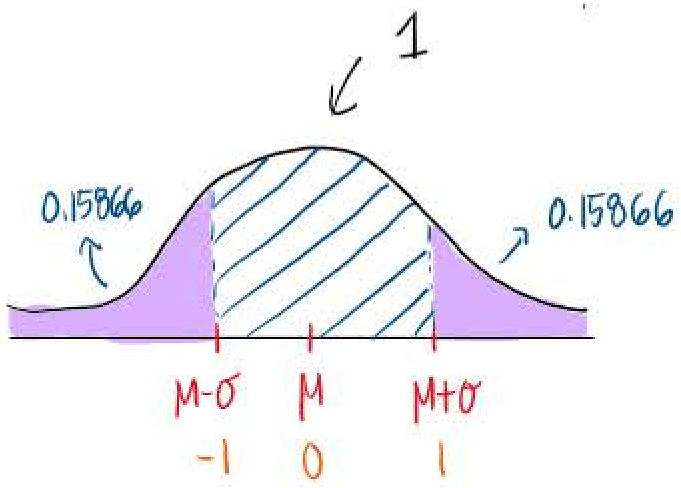
50% error

$S_x = \pm 0.103$

$\pm 0.6745\,(0.103) = \pm 0.069$

Most probable value = 145.66
Minimum probable value =145.591
Maximum probable value = 145.729

145.66 ± 0.069 //



P(⟶ area to the left

Q(⟶ middle area

R(⟶ area to the right

P(-1) = 0.15866

2. A series of 10 angles was measured, each angle with an estimated error of ± 14 seconds of arc. What is the total estimated error in the 11 angles?

$n = 10 \qquad E_{series} = \pm E\sqrt{n} \qquad 36^\circ\ 24'\ 32''$

$E = \pm 14''$

$E_{series} = \pm\ 14''\sqrt{10} = \boxed{0^\circ\ 0'\ 44.27''}$ //

3. In five trials of walking along a 40m course on fairly level ground, a pacer for a survey party counted 50, 51, 50.5, 51.5, and 50.75 paces respectively. He then started walking an unknown distance XY in four trials which were recorded as follows: 87, 87.5, 86.5, and 87 paces. Determine the length of line XY.

$\bar{x} = \dfrac{50 + 51 + 50.5 + 51.5 + 50.75}{5} = 50.75 \text{ paces}$

50
51
50.5
51.5
50.75

$\text{pace factor} = \dfrac{\text{distance}}{\text{no. of paces}} = \dfrac{40\text{m}}{50.75 \text{ paces}} = 0.788 \dfrac{\text{m}}{\text{pace}}$

XY
87
87.5
86.5
87

$\dfrac{87 + 87.5 + 86.5 + 87}{4} = 87 \text{ paces}$

$XY = 87 \text{ paces} \left(0.788 \dfrac{\text{m}}{\text{pace}}\right) = \boxed{68.556\text{m}}$ //

4. A steel tape with a coefficient of linear expansion of 0.0000116/ºC is known to be 50m long at 25ºC. The tape was used to **lay out** a line of 542.90 meters. The temperature in the field was found to be 22ºC. Determine the following:

a. Temperature correction per tape length

b. Temperature correction for the laid out line

c. Correct length of the line

Measuring:

Laying Out

$$\alpha = k = \frac{0.0000116}{°C}$$

$L_t = 50m \quad @T_s = 25°C$ → standard temperature

Laying out - subtract errors
Measuring - add errors

$L = 542.9m$

$T_a = 22°C$

a. C_T per tape length $\qquad \Delta T = T_a - T_s$

$$C_T = \alpha L_t(\Delta T)$$

$$C_T = \frac{0.0000116}{°C}(50m)(22-25)°C = \boxed{-0.00174m \text{ (too short)}}$$ ← per tape length

b. $$C_{Total} = -0.00174m\left(\frac{542.9m}{50m}\right) = \boxed{-0.0189m \text{ (too short)}}$$

$$C_T = \alpha L(\Delta T)$$

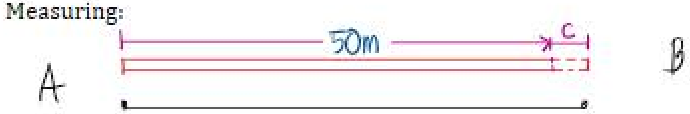
4. A steel tape with a coefficient of linear expansion of 0.0000116/°C is known to be 50m long at 25°C. The tape was used to **lay out** a line of 542.90 meters. The temperature in the field was found to be 22°C. Determine the following:

a. Temperature correction per tape length

b. Temperature correction for the laid out line

c. Correct length of the line

Measuring:



Laying Out

$\alpha = k = \frac{0.0000116}{°C}$

$L_t = 50m \quad @T_s = 25°C$ → standard temperature

Laying out - subtract errors
Measuring - add errors

$L = 542.9m$

$T_a = 22°C$

a. C_T per tape length $\qquad \Delta T = T_a - T_s$

$C_T = \alpha L_t (\Delta T)$

$C_T = \frac{0.0000116}{°C}(50m)(22-25)°C = \boxed{-0.00174m \text{ (too short)}}$ // ← per tape length

b. $C_{Total} = -0.00174m\left(\frac{542.9m}{50m}\right) = \boxed{-0.0189m \text{ (too short)}}$ //

$C_T = \alpha L (\Delta T)$

$= \frac{0.0000116}{°C}(542.9m)(22-25)°C = -0.0189m$

c. correct length

$L_f = L_i \pm C_{Total}$

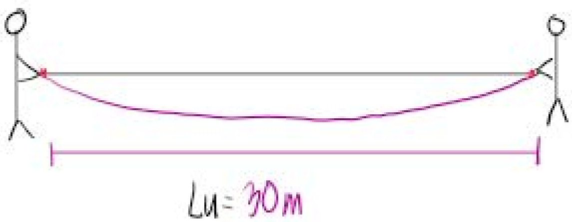
$L_f = 542.9 - (-0.0189m) = \boxed{542.9189m}$ //

↓ laying out

5. A 30m tape is supported only at its ends under a steady pull of 7kg. If the tape weighs 0.035kg/m, determine the following:

   a. Sag correction per tape length

   b. If the surveyor has measured a distance of 90m with this tape, determine the corrected distance.



$$C_s = \frac{w^2 L_u^3}{24P^2}$$ (always negative)

w=weight of tape in lb/ft or kg/m
L=unsupported length of the tape
P=actual pull or tension applied

a. $$C_s = \frac{(0.035\,\frac{kg}{m})^2 (30m)^3}{24\,(7kg)^2} = \boxed{-0.028125m \text{ (too short)}}$$ //

b. 90m

$$\frac{90m}{30m} = 3 \text{ times}$$

$$C_{s_{Total}} = \frac{90m}{30m}(-0.028125m) = -0.084375m \text{ (too short)}$$

$$L_f = 90m + (-0.084375) = \boxed{89.915625m}$$ //

↓ measuring

6. A 50-m steel tape is of standard length under a pull of 5.8kg when supported throughout its entire length. The tape has a cross-sectional area of 0.04 sq. cm. and being made of steel, its modulus of elasticity is $2.1\times10^6 kg/cm^2$. This tape was used in the field and the surveyor measures a distance of 546.45m. At the time the measurement was made, the constant pull applied was 8kg. Determine the correct length of the line.

P_s (5.8kg), P_a (8kg)

$$C_P = \frac{(P_a - P_s)L}{AE} = \frac{(8-5.8)kg(546.45m)}{0.04cm^2\left(2.1\times10^6 \frac{kg}{cm^2}\right)}$$

$$= 0.0143m \text{ (too long)}$$

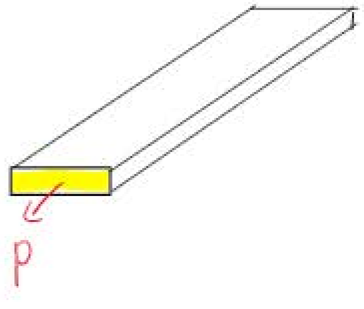
$P_a = 8kg$

$P_s = 5.8kg$

$A = 0.04 cm^2$

$E = 2.1\times10^6 \frac{kg}{cm^2}$

$L = 546.45m$

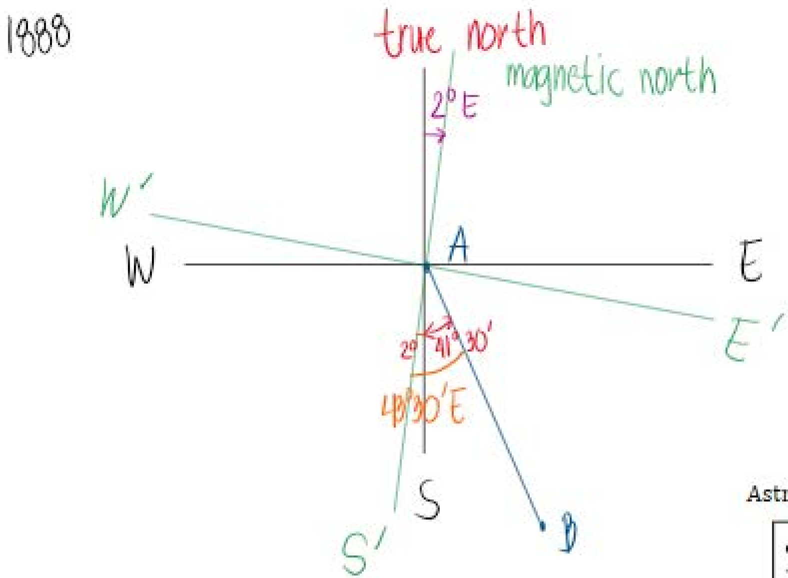


$$L_f = L_i \pm C_{Total}$$

$$= 546.45 + 0.0143 = \boxed{546.4643m}$$

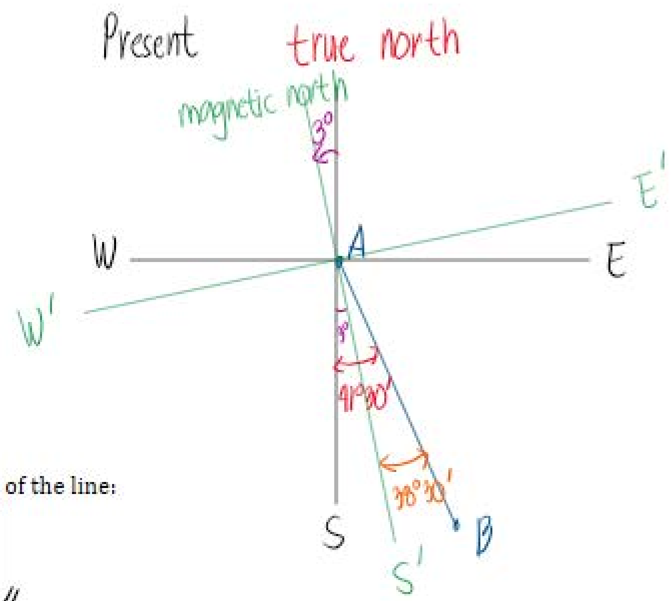
Problem 1:

The magnetic bearing of line AB was recorded as S43°30'E in 1888. If the magnetic declination was 2°00'E, what is the astronomic bearing of the line? If the declination is now 3°00'W, what is the magnetic bearing of the line today?



Astronomic bearing of the line:

S41°30'E //



Magnetic bearing:

S 38°30' E //