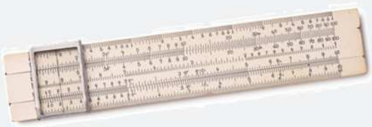

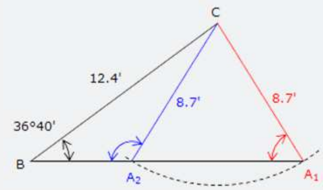

Math Problem Examples

Mentoring Mondays, 1 Nov 2021
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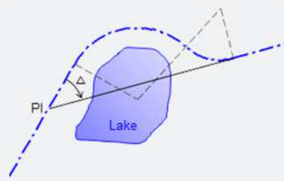

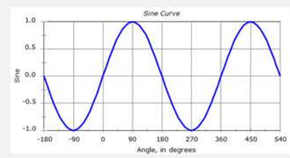

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Math Problem Examples

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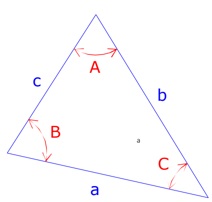
Useful Equations and Relationships

Triangles



Angle condition $A + B + C = 180°00'00"$

Las of Sines $\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$

Law of Cosines

$a^2 = b^2 + c^2 - 2 \times (bc) \times \cos(A)$

$b^2 = c^2 + a^2 - 2 \times (ca) \times \cos(B)$

$c^2 = a^2 + b^2 - 2 \times (ab) \times \cos(C)$

Area

$\frac{1}{2}(ab) \times \sin(C)$

$\frac{1}{2}(bc) \times \sin(A)$

$\frac{1}{2}(ca) \times \sin(B)$

$\sqrt{s \times (s-a) \times (s-b) \times (s-c)}$

$s = \frac{a+b+c}{2}$

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Math Problem Examples

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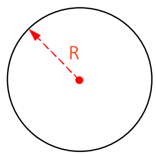
Useful Equations and Relationships

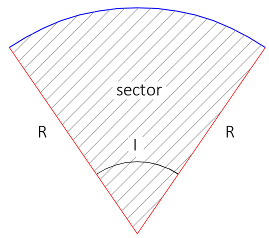
Circles and Arcs



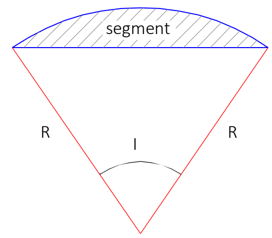
Area = πR^2

Perimeter = $2\pi R$

where R is the circle radius.



$$\text{Area} = \frac{I \times \pi \times R^2}{360°}$$



$$\text{Area} = R^2\left(\frac{\pi \times I}{360°} - \frac{\sin(I)}{2}\right)$$

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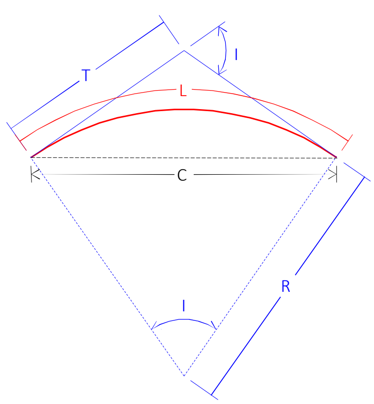
Useful Equations and Relationships

Circular Curves



$$L = \frac{I \times \pi \times R}{180°} = 100 \times \left(\frac{I}{D}\right)$$

$$R = \frac{5729.58}{D}$$

$$C = 2R \times \sin\left(\frac{I}{2}\right)$$

$$T = R \times \tan\left(\frac{I}{2}\right)$$

R : radius; ft

L : arc length; ft

C : chord length; ft

T : tangent length; ft

D : degree of curvature,
arc definition; degrees

I : central angle; degrees

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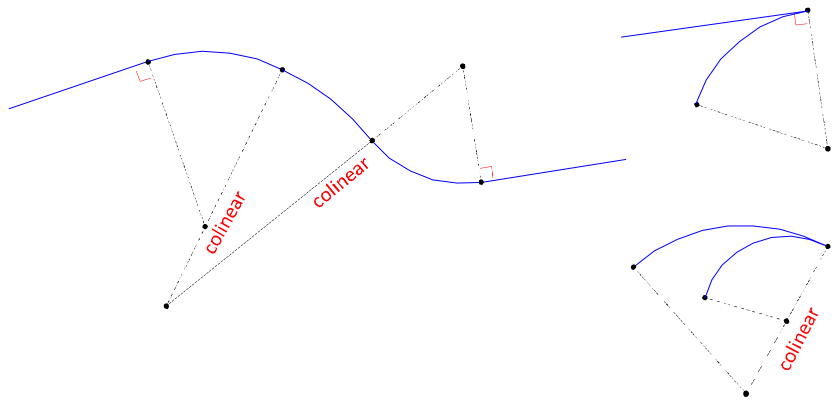
Useful Equations and Relationships

Circular Curves – Tangency

Perpendicular and colinear conditions



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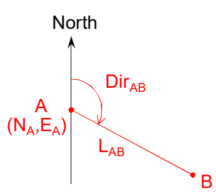
Useful Equations and Relationships

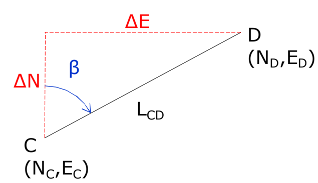
Coordinates

Forward Computation

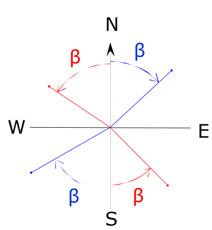


$$N_B = N_A + Lat_{AB}$$
$$= N_A + L_{AB} \times \cos(Dir_{AB})$$
$$E_B = E_A + Dep_{AB}$$
$$= E_A + L_{AB} \times \sin(Dir_{AB})$$

Inverse Computation



$$\Delta N = N_D - N_C$$
$$\Delta E = E_D - E_C$$
$$L_{CD} = \sqrt{\Delta N^2 + \Delta E^2}$$
$$\beta = \tan^{-1}\left[\frac{\Delta E}{\Delta N}\right]$$



Algebraic sign

Quad	*ΔN*	*ΔE*	β	Bearing	Azimuth
NE	+	+	+	N β E	β
SE	–	+	–	S | β | E	180°+ β
SW	–	–	+	S β W	180°+ β
NW	+	–	–	N | β| W	360°+ β

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Math Problem Examples

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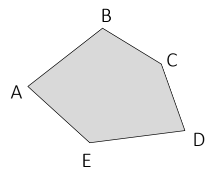
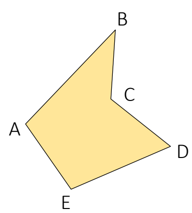
Useful Equations and Relationships

Coordinates: Area computations





		(↗)	(↘)
N_A	E_A	$N_B \times E_A$	
N_B	E_B	$N_C \times E_B$	$N_A \times E_B$
N_C	E_C	$N_D \times E_C$	$N_B \times E_C$
N_D	E_D	$N_E \times E_D$	$N_C \times E_D$
N_E	E_E	$N_A \times E_E$	$N_D \times E_E$
N_A	E_A		$N_E \times E_A$
	sums:	Σ(↗)	Σ(↘)

$$Area = \frac{\Sigma(\nearrow) - \Sigma(\searrow)}{2}$$

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Math Problem Examples

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Rounding may be an issue depending on how many significant figures are shown in the problem and carried in the calculations (yours and the authors).

It's usually safest to carry additional decimal places in your comps

You may have to pick the answer that's closest to what you compute. The difference is probably a reflection of the number of digits carried in computations.

On questions with multiple choice answers, you can sometimes (not always) use logic/reasoning to narrow the choices.

Can one or more answers be eliminated because they "behave" incorrectly?

Example: taping distance in cold temps, the tape shrinks so recorded measurements are *too long*. Toss the answers that are *too short*.

In a time crunch, logical analysis might help increase odds of "guessing" correctly.

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Math Problem Examples

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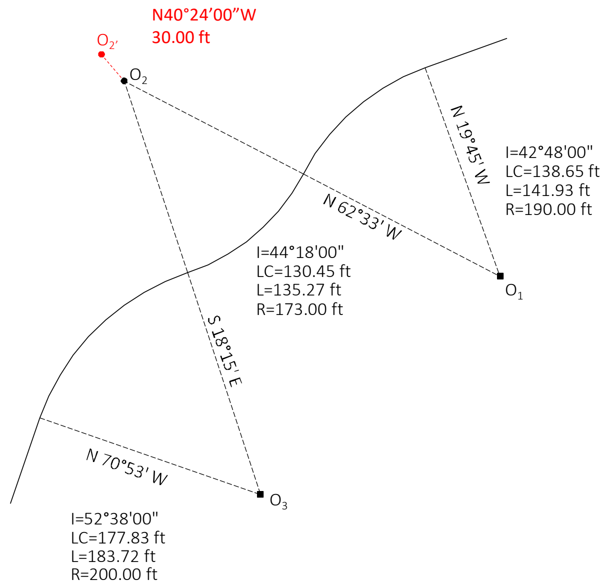
Problem A. The centerline of a street must be relocated. The center of the second curve will be shifted N40°24’00”W 30.00 ft, keeping its 173.00 ft radius.
The centers of the other curves will not move, but their curve geometries will change.



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Math Problem Examples

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Problem A. The centerline of a street must be relocated. The center of the second curve will be shifted N40°24’00”W 30.00 ft, keeping its 173.00 ft radius.
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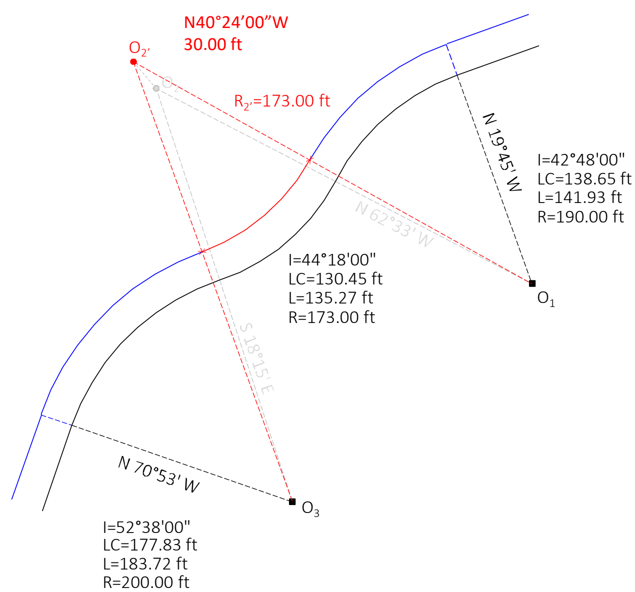

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Math Problem Examples

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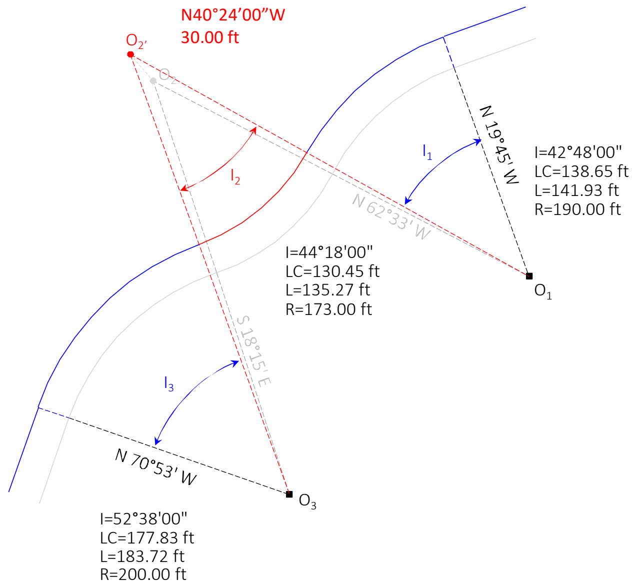
Part A.1 What are the new central angles for the three curves?

	Curve 1	*Curve 2*	*Curve 3*
a.	41°08′30″	41°01′24″	51°00′54″
b.	41°48′08″	42°00′15″	53°38′23″
c.	42°35′39″	44°18′25″	51°52′02″
d.	42°40′15″	40°31′00″	52°35′50″



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Math Problem Examples

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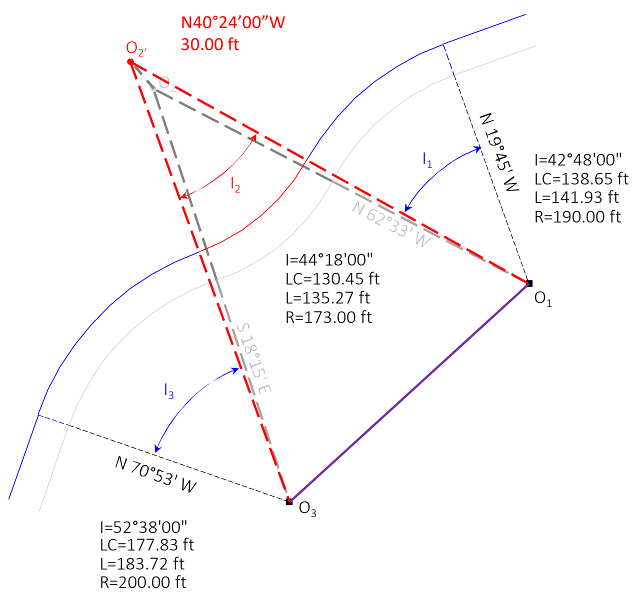
Part A.1 What are the new central angles for the three curves?

Solution logic?

We could solve multiple triangles.



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Math Problem Examples

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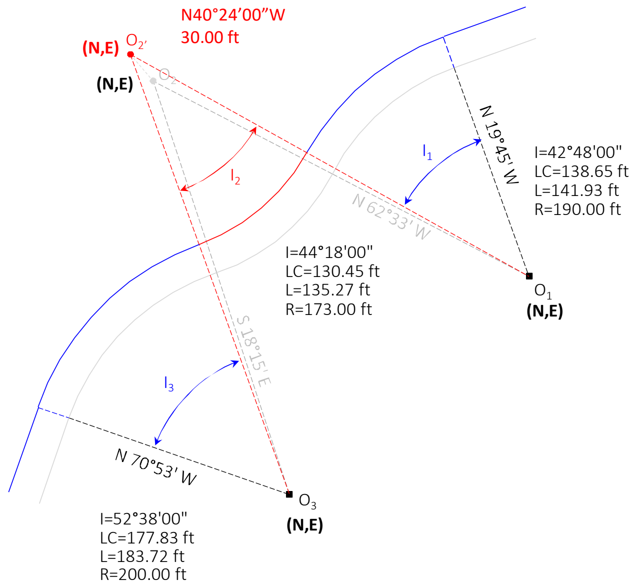
Part A.1 What are the new central angles for the three curves?

Solution logic?

We could solve multiple triangles.

Or use COGO: I-angles are between directions



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Math Problem Examples

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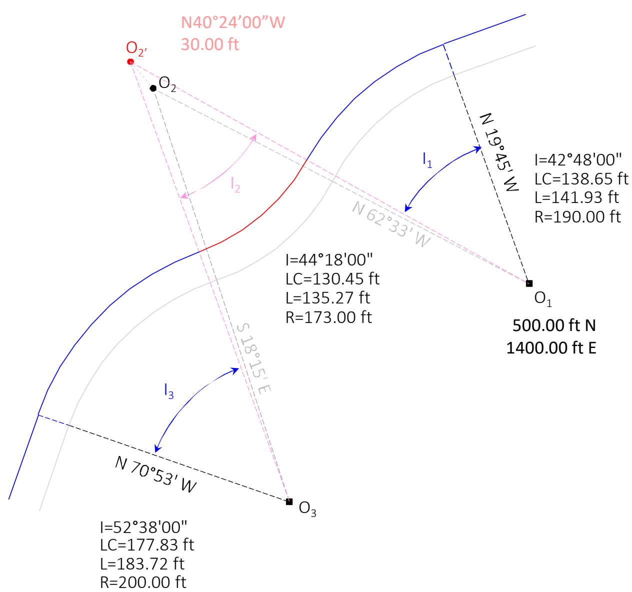
Part A.1 What are the new central angles for the three curves?

Using COGO

Start at O_1 using 500.00 ft N, 1400.00 ft E (assumed)



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Math Problem Examples

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Part A.1 What are the new central angles for the three curves?

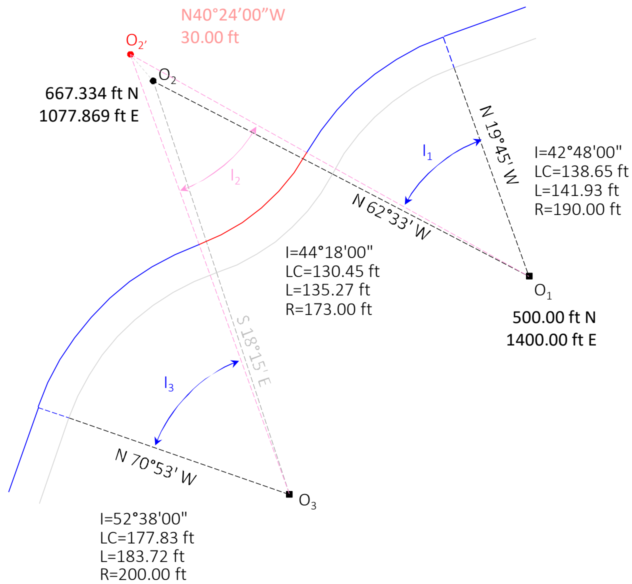
Using COGO

Forward Comp to O_2:

$$Az = 360°00'00" - 62°33'00" = 297°27'00"$$

$$N = 500.00ft + (190.00ft + 173.00ft) \times \cos(297°27'00")$$
$$= 667.334ft$$

$$E = 1400.00ft + (190.00ft + 173.00ft) \times \sin(297°27'00")$$
$$= 1077.869ft$$



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Math Problem Examples

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Part A.1 What are the new central angles for the three curves?

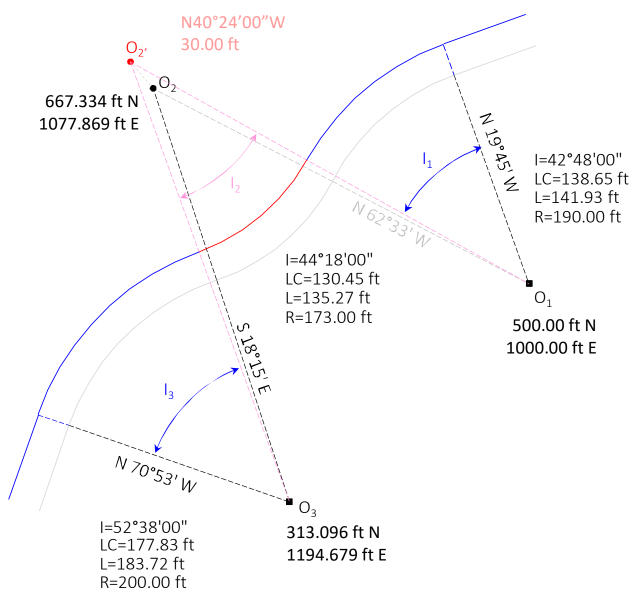
Using COGO

From O_2 to O_3:

$$Az = 180°00'00" - 18°15'00" = 161°45'00"$$

$$N = 667.334ft + (173.00ft + 200.00ft) \times \cos(161°45'00")$$
$$= 313.096ft$$

$$E = 1077.869ft + (173.00ft + 200.00ft) \times \sin(161°45'00")$$
$$= 1194.679ft$$



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Math Problem Examples

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Part A.1 What are the new central angles for the three curves?

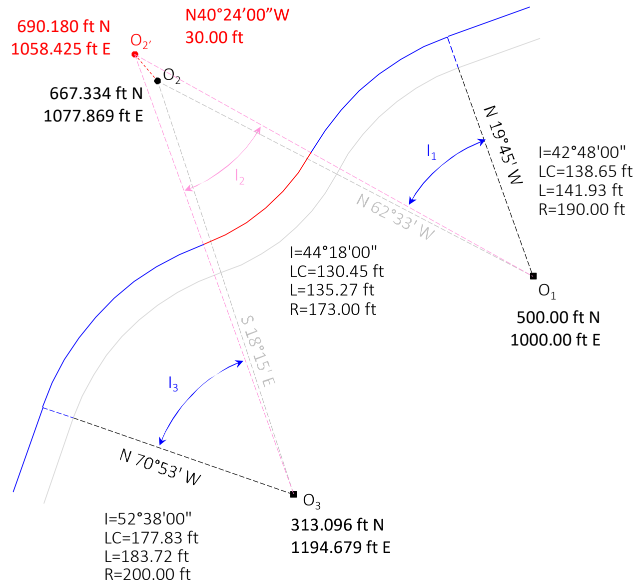
Using COGO

From O_2 to $O_{2'}$:

$$Az = 360°00'00" - 40°24'00" = 319°36'00"$$

$$N = 667.334ft + 30.00ft \times \cos(319°36'00")$$
$$= 690.180ft$$

$$E = 1077.869ft + 30.00ft \times \sin(319°36'00")$$
$$= 1058.425ft$$



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Math Problem Examples

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Part A.1 What are the new central angles for the three curves?

Using COGO

Inverse from $O_{2'}$ to O_1:

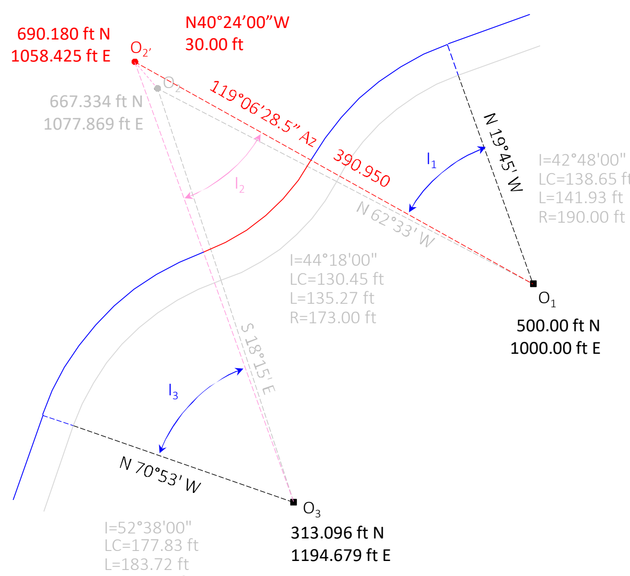
$$\Delta N = 500.00ft - 690.180ft = -190.180ft$$

$$\Delta E = 1400.00ft - 1058.425ft = +341.575ft$$

$$L = \sqrt{(-190.180ft)^2 + (+341.575ft)^2} = 390.950ft$$

$$\alpha = \tan^{-1}\left[\frac{+341.575ft}{-190.180ft}\right]_S^E = -60°53'31.5"$$

$$Az = 119°06'28.5"$$



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Math Problem Examples

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Part A.1 What are the new central angles for the three curves?

Using COGO

Inverse from $O_{2'}$ to O_3:

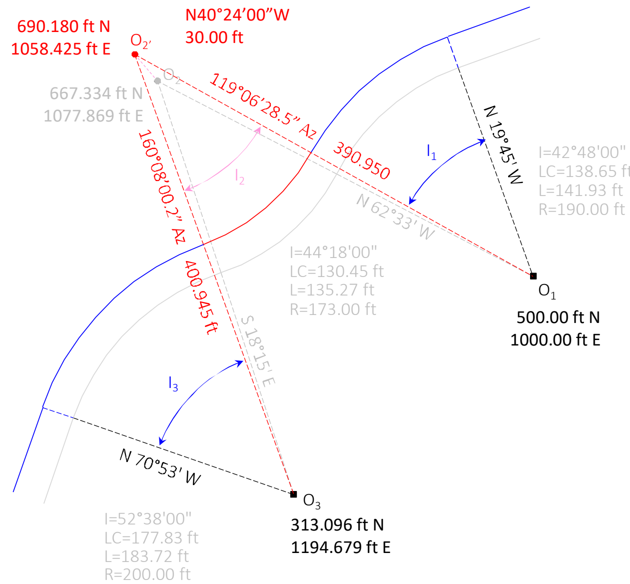
$$\Delta N = 313.096\text{ft} - 690.180\text{ft} = -377.084\text{ft}$$

$$\Delta E = 1194.679\text{ft} - 1058.425\text{ft} = +136.254\text{ft}$$

$$L = \sqrt{(-377.084\text{ft})^2 + (+136.254\text{ft})^2} = 400.945\text{ft}$$

$$\alpha = \tan^{-1}\left[\frac{+136.254\text{ft}}{-377.084\text{ft}}\right]_S^E = -19°51'59.8"$$

$$Az = 160°08'00.2"$$



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Part A.1 What are the new central angles for the three curves?

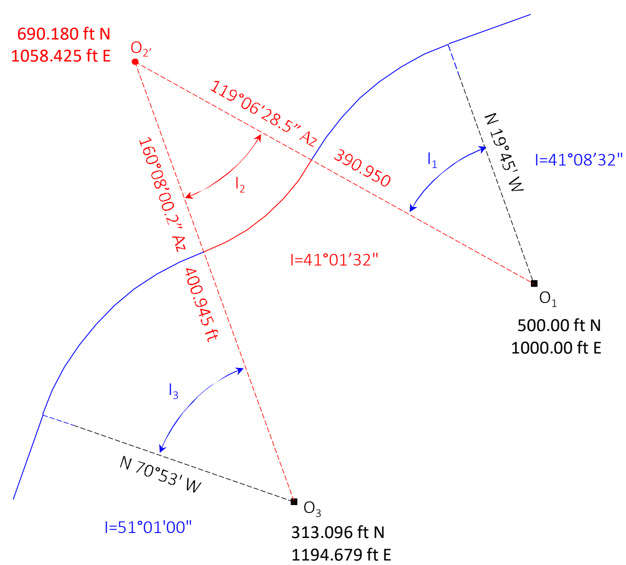
Using COGO

Compute differences between directions:

$$I_1 = (360°00'00" - 19°45'00") - (119°06'28.5" + 180°00'00")$$
$$= 41°08'31.5" = \underline{41°08'32"}$$

$$I_2 = 160°08'00.2" - 119°06'28.5"$$
$$= 41°01'31.7" = \underline{41°01'32"}$$

$$I_3 = (160°08'00.2" + 180°00'00") - (360°00'00" - 70°53'00")$$
$$= 51°01'00.2" = \underline{51°01'00"}$$



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Math Problem Examples

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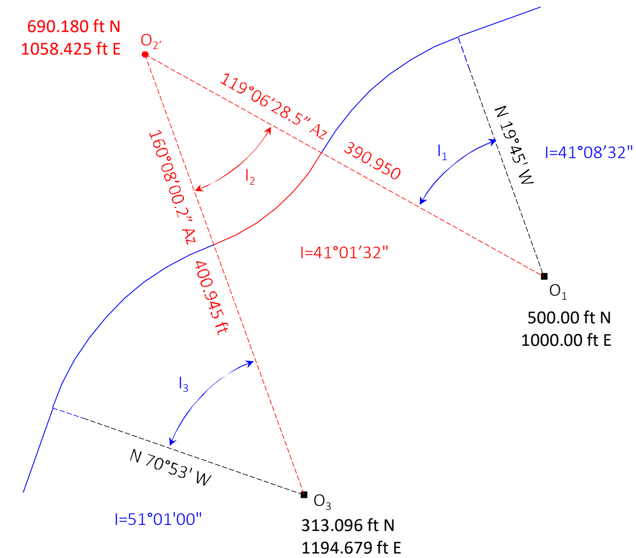
Part A.1 What are the new central angles for the three curves?

	Curve 1	*Curve 2*	*Curve 3*	
a.	41°08'30"	41°01'24"	51°00'54"	*Closest...*
b.	41°48'08"	42°00'15"	53°38'23"	
c.	42°35'39"	44°18'25"	51°52'02"	
d.	42°40'15"	40°31'00"	52°35'50"	



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Math Problem Examples

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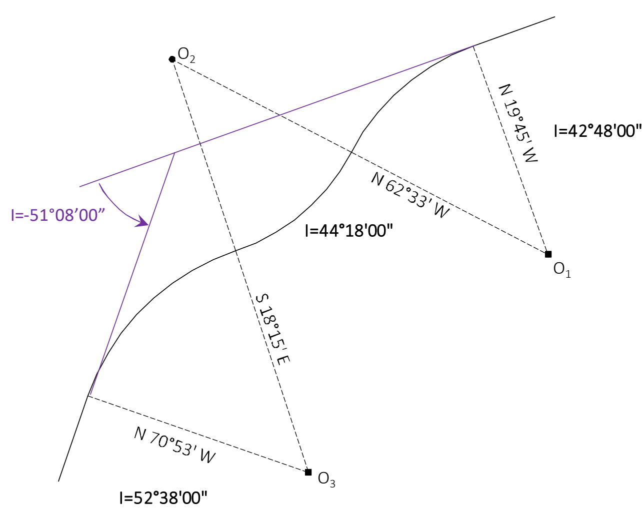
Part A.1 What are the new central angles for the three curves?
Logical analysis?

The total I angle is the sum of the three curves' I angles, right are +, left are -

$$I = (-42°48'00") + 44°18'00" + (-52°38'00")$$
$$= -51°08'00"$$



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Math Problem Examples

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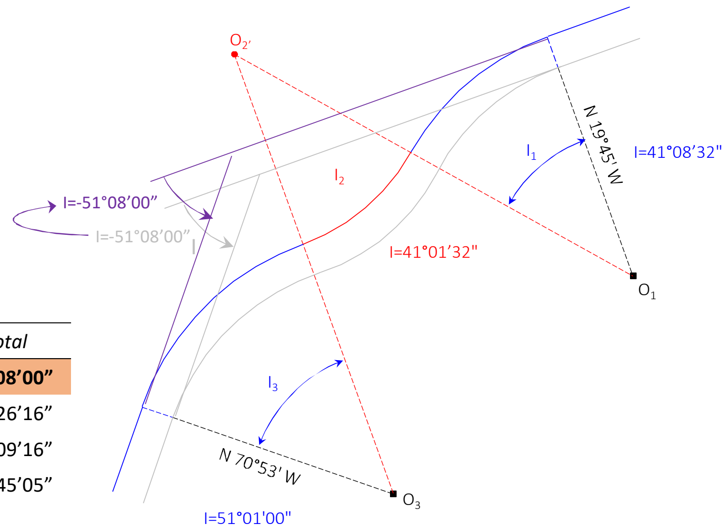
Part A.1 What are the new central angles for the three curves?
Logical analysis?

This is preserved with the re-alignment.
Compute the totals of the answers.

$I = (-I_1") + I_2 + (-I_3) = -51°08'00"$

Only **a** meets the requirement.

	Curve 1 (-)	*Curve 2 (+)*	*Curve 3 (-)*	*Total*
a.	41°08'30"	41°01'24"	51°00'54"	**-51°08'00"**
b.	41°48'08"	42°00'15"	53°38'23"	-53°26'16"
c.	42°35'39"	44°18'25"	51°52'02"	-50°09'16"
d.	42°40'15"	40°31'00"	52°35'50"	-54°45'05"



$$I = (-41°08'32") + 41°01'32" + (-51°01'00")$$
$$= -51°08'00"$$

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Math Problem Examples

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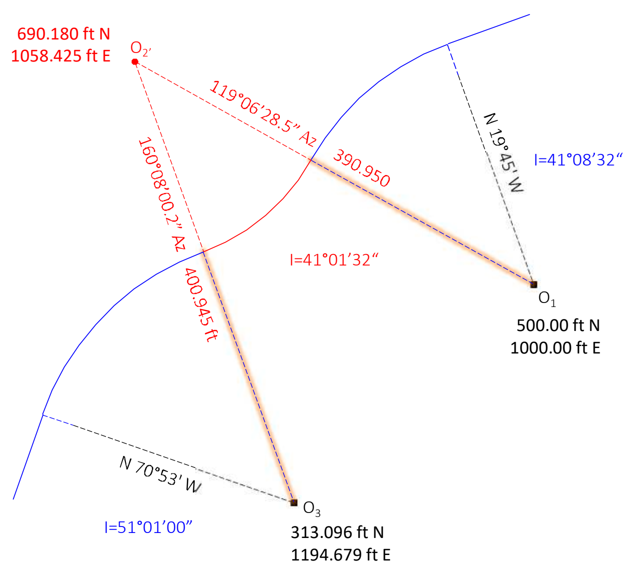
Part A.2 What are the new new radii of curves 1 and 3?

	Curve 1	*Curve 2*	*Curve 3*
a.	190.00 ft	173.00 ft	200.00 ft
b.	190.00 ft	200.93 ft	200.00 ft
c.	204.62 ft	186.31 ft	214.98 ft
d.	217.95 ft	173.00 ft	227.96 ft



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Math Problem Examples

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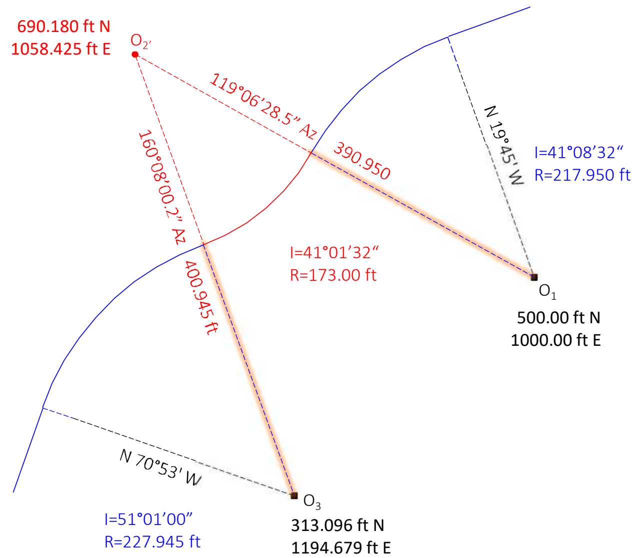
Part A.2 What are the new new radii of curves 1 and 3?

R_2 stays at 173.00 ft. Subtract it from the COGO inverse distances O_1-$O_{2'}$ and $O_{2'}$-O_3:

$$R_1 = 390.950\text{ft} - 173.00\text{ft} = \underline{217.950\text{ft}}$$
$$R_3 = 400.945\text{ft} - 173.00\text{ft} = \underline{227.945\text{ft}}$$

	Curve 1	*Curve 2*	*Curve 3*
a.	190.00 ft	173.00 ft	200.00 ft
b.	190.00 ft	200.93 ft	200.00 ft
c.	204.62 ft	186.31 ft	214.98 ft
d.	217.95 ft	173.00 ft	227.96 ft



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Math Problem Examples

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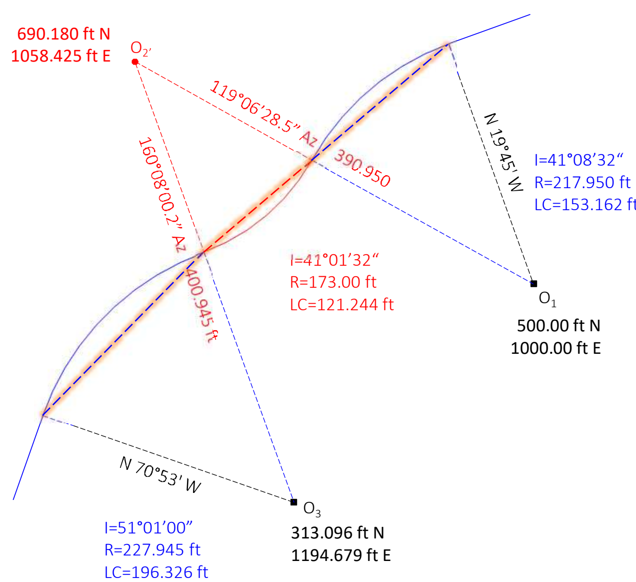
Part A.3 What are the new long chords of each curve?

	Curve 1	*Curve 2*	*Curve 3*
a.	153.16 ft	121.24 ft	196.33 ft
b.	154.66 ft	123.88 ft	202.96 ft
c.	155.32 ft	115.69 ft	202.96 ft
d.	155.48 ft	135.27 ft	135.27 ft



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Math Problem Examples

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Part A.3 What are the new long chords of each curve?

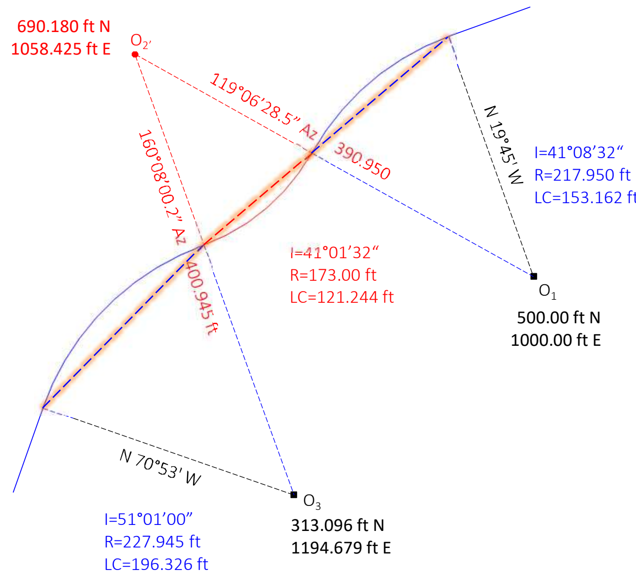
$$LC = 2 \times R \times \sin\left(\frac{I}{2}\right)$$

$$LC_1 = 2 \times 217.95ft \times \sin\left(\frac{41°08'32''}{2}\right) = \underline{153.162ft}$$

$$LC_2 = 2 \times 173.00ft \times \sin\left(\frac{41°01'32''}{2}\right) = \underline{121.244ft}$$

$$LC_3 = 2 \times 227.945ft \times \sin\left(\frac{51°01'00''}{2}\right) = \underline{196.326ft}$$

	Curve 1	*Curve 2*	*Curve 3*
a.	153.16 ft	121.24 ft	196.33 ft
b.	154.66 ft	123.88 ft	202.96 ft
c.	155.32 ft	115.69 ft	202.96 ft
d.	155.48 ft	135.27 ft	135.27 ft



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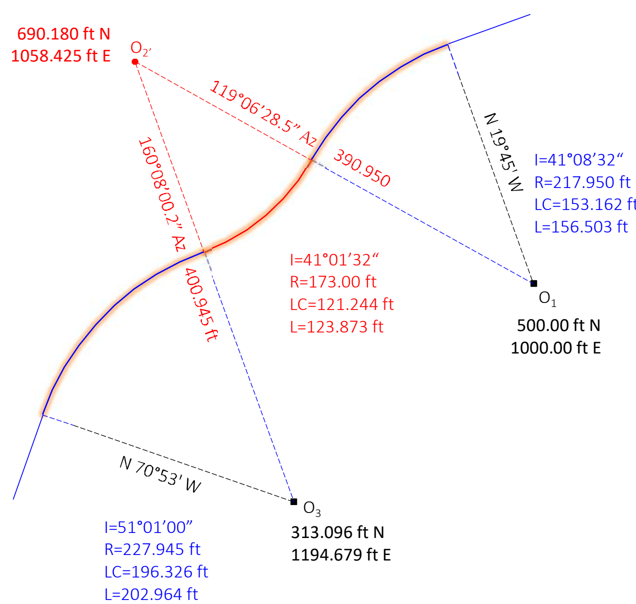
Part A.4 What are the arc lengths of each curve?

	Curve 1	*Curve 2*	*Curve 3*
a.	143.67 ft	127.37 ft	231.07 ft
b.	153.14 ft	121.25 ft	196.33 ft
c.	155.03 ft	128.93 ft	200.86 ft
d.	156.50 ft	123.87 ft	202.97 ft



Mentoring Mondays
Math Problem Examples

Jerry Mahun 01 Nov 2021

Part A.4 What are the arc lengths of each curve?

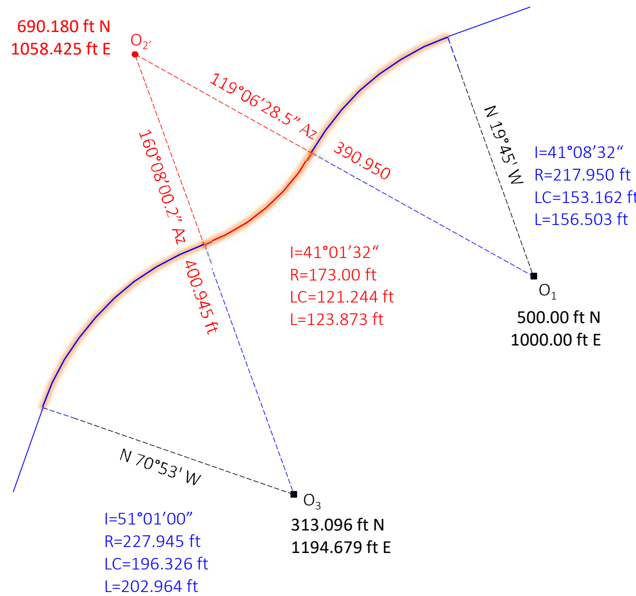
$$L = R \times I_R = R \times I \times \left(\pi/180°\right)$$

$$L_1 = 217.950\text{ft} \times 41°08'32" \times \left(\pi/180°\right) = \underline{156.503\text{ft}}$$

$$L_2 = 173.00\text{ft} \times 41°01'32" \times \left(\pi/180°\right) = \underline{123.873\text{ft}}$$

$$L_3 = 227.945\text{ft} \times 51°01'00" \times \left(\pi/180°\right) = \underline{202.964\text{ft}}$$

	Curve 1	*Curve 2*	*Curve 3*
a.	143.67 ft	127.37 ft	231.07 ft
b.	153.14 ft	121.25 ft	196.33 ft
c.	155.03 ft	128.93 ft	200.86 ft
d.	156.50 ft	123.87 ft	202.97 ft



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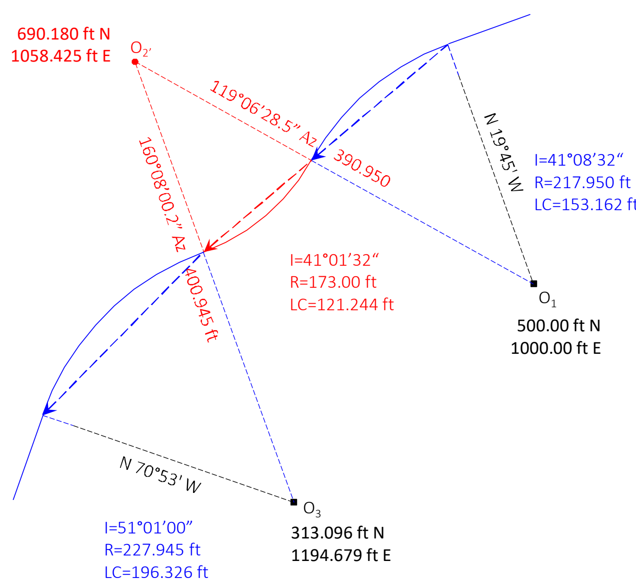
Math Problem Examples

Jerry Mahun 01 Nov 2021

Part A.5 What is the bearing of each long chord?

	Curve 1	*Curve 2*	*Curve 3*
a.	S48°51'00"W	S49°36'00"W	S45°26'00"W
b.	S49°15'54"W	S49°36'51"W	S45°01'48"W
c.	S49°40'45"W	S49°37'18"W	S44°37'44"W
d.	S49°51'25"W	S49°26'09"W	S44°59'43"W



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Math Problem Examples

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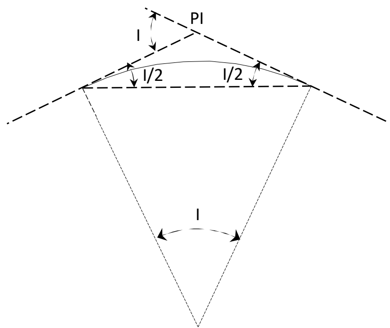
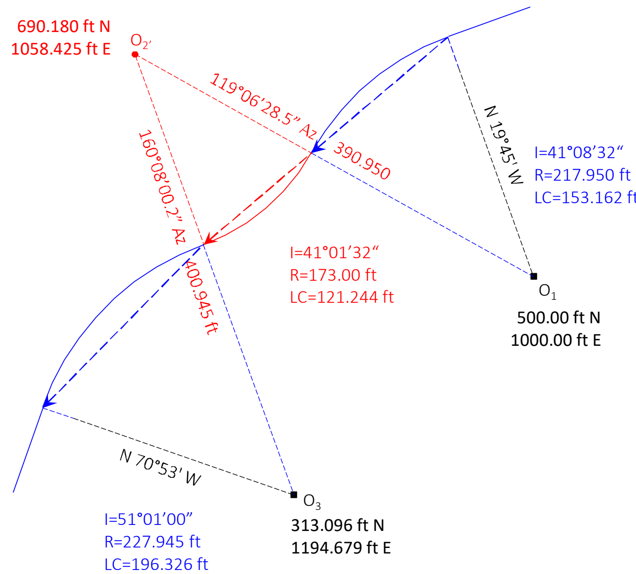
Part A.5 What is the bearing of each long chord?

For a circular curve:

The deflection angle between tangents at the PI is I.
The angle between the chord and the tangent at either end of the curve is (I/2)





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Math Problem Examples

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Part A.5 What is the bearing of each long chord?

Azimuth of the first tangent PC_1-PI_1:

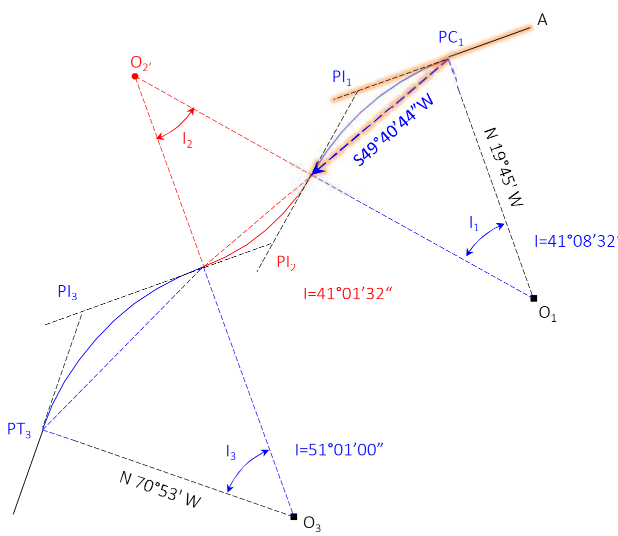
$$Az = (180°00'00" - 19°45') + 90°00'00"$$
$$= 250°15'00"$$

Azimuth of Curve 1 chord

$$Az = 250°15'00" + \left(\frac{-41°08'32"}{2}\right)$$
$$= 229°40'44"$$

Bearing of Curve 1 chord

$$\alpha = 229°40'44" - 180°00'00"$$
$$= 49°40'44"$$
$$\Rightarrow \underline{S49°40'44"W}$$



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Math Problem Examples

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Part A.5 What is the bearing of each long chord?

Azimuth of the tanget PI_1-PI_2:

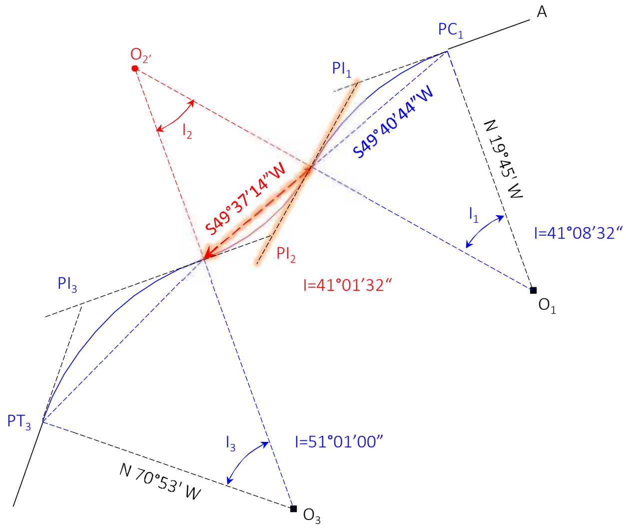
$$Az = 250°15'00" + (-41°08'32")$$
$$= 209°06'28"$$

Azimuth of Curve 2 chord

$$Az = 209°06'28" + \left(41°01'32"/2\right)$$
$$= 229°37'14"$$

Bearing of Curve 2 chord

$$\beta = 229°37'14" - 180°00'00"$$
$$= 49°37'14"$$
$$\Rightarrow \underline{S49°37'14"W}$$



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Math Problem Examples

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Part A.5 What is the bearing of each long chord?

Azimuth of the tanget PI_2-PI_3:

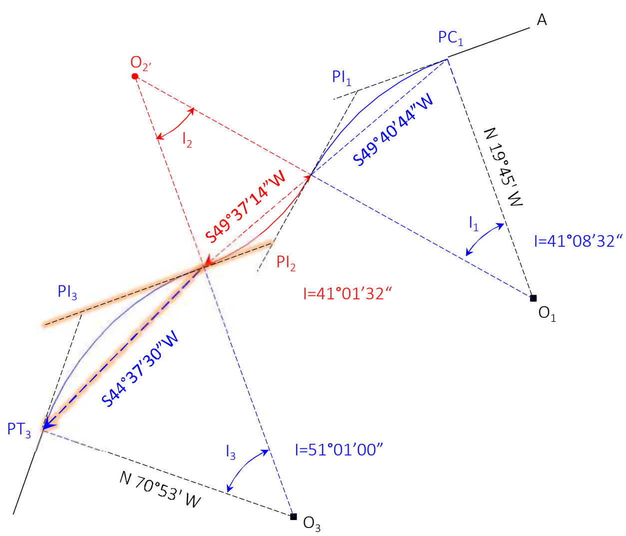
$$Az = 209°06'28" + 41°01'32"$$
$$= 250°08'00"$$

Azimuth of Curve 3 chord

$$Az = 250°08'00" + \left(-51°01'00"/2\right)$$
$$= 224°37'30"$$

Bearing of Curve 3 chord

$$\beta = 224°37'30" - 180°00'00"$$
$$= 44°37'30"$$
$$\Rightarrow \underline{S44°37'30"W}$$



Mentoring Mondays
Math Problem Examples

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Part A.5 What is the bearing of each long chord?

Math check: Azimuth of the tanget PI_3-PT_3:

$$Az = 250°08'00" + (-51°01'00") \\ = 199°07'00"$$

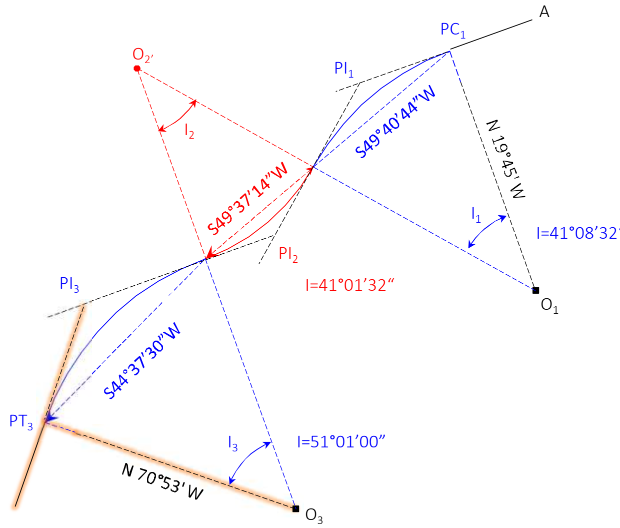
Azimuth of Curve 3 radius at PT_3:

$$Az = 199°07'00" - 90°00'00" \\ = 109°07'00"$$

Bearing of Curve 3 radius at PT_3:

$$\beta = 180°00'00" - 109°07'00" \\ = 70°53'00" \\ \Rightarrow \underline{S70°53'00"E}$$

check

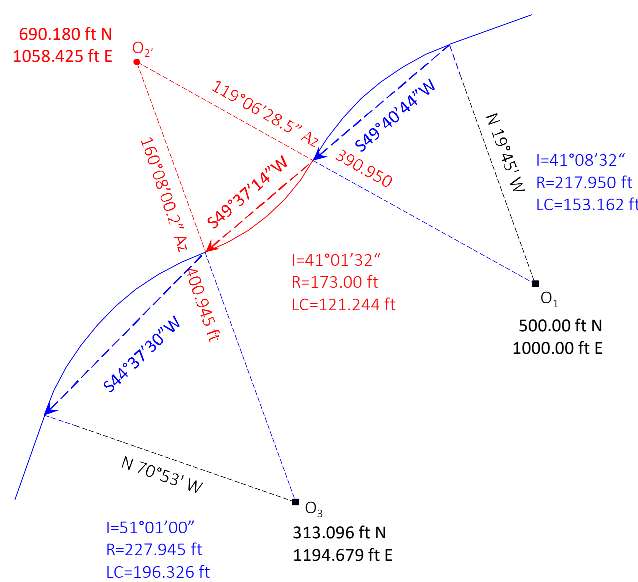


Mentoring Mondays
Math Problem Examples

Jerry Mahun 01 Nov 2021

Part A.5 What is the bearing of each long chord?

	Curve 1	*Curve 2*	*Curve 3*	
a.	S48°51'00"W	S49°36'00"W	S45°26'00"W	
b.	S49°15'54"W	S49°36'51"W	S45°01'48"W	
c.	S49°40'45"W	S49°37'18"W	S44°37'44"W	*Closest…*
d.	S49°51'25"W	S49°26'09"W	S44°59'43"W	



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Math Problem Examples

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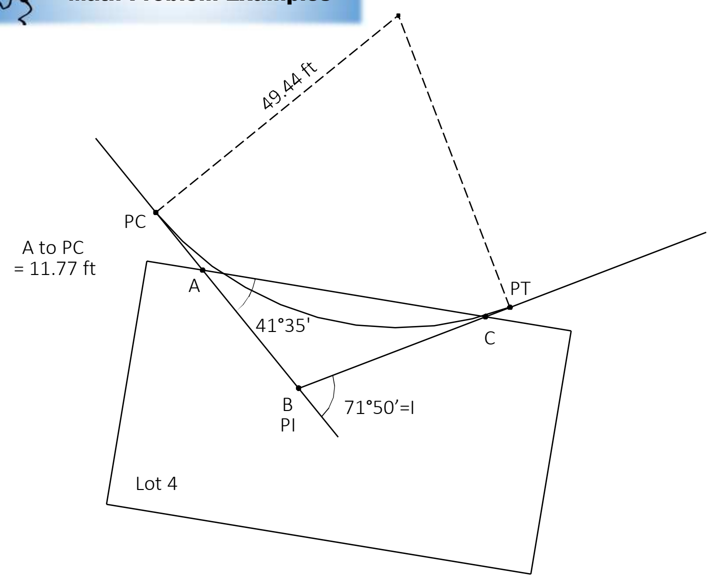

Problem B. The circular curve encroaches onto Lot 4. It will be replaced by a compound curve tangent to the northern boundary of Lot 4.

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Math Problem Examples

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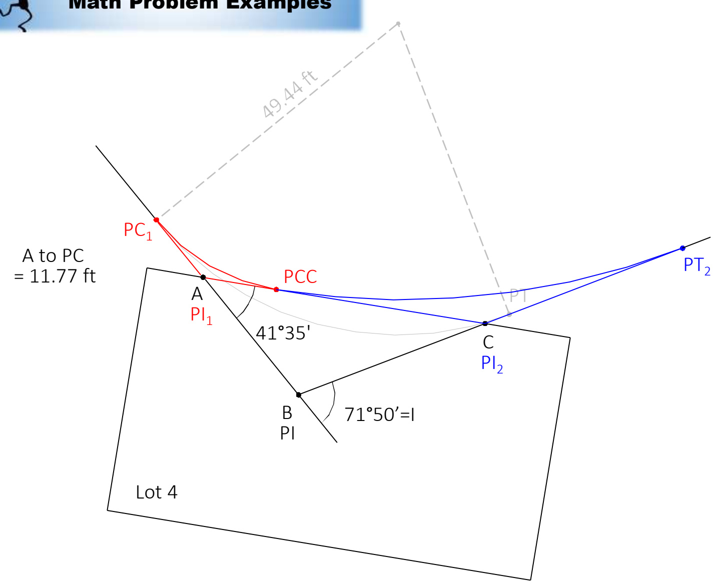

Problem B. The circular curve encroaches onto Lot 4. It will be replaced by a compound curve tangent to the northern boundary of Lot 4.

The existing PC will be the start of the first curve and point A will serve as its PI, C will be the PI of the second curve.

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Math Problem Examples

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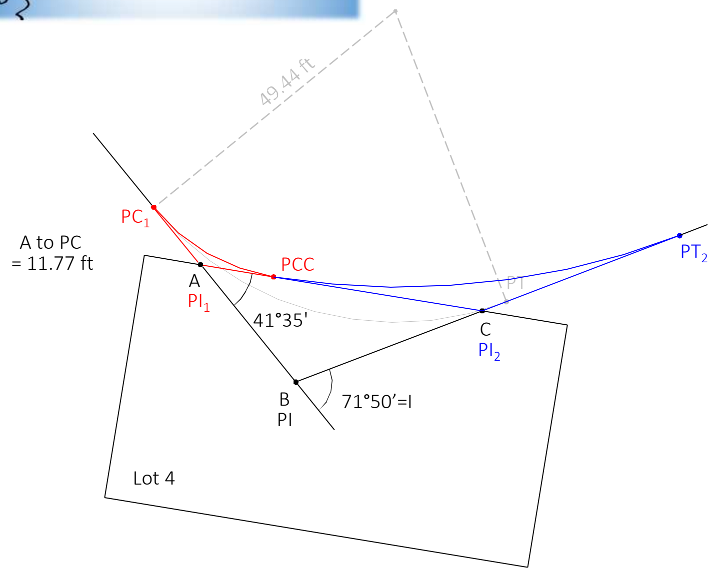

Part B.1 What is the radius of the first curve?

a. 31.00 ft
b. 47.35 ft
c.. 49.44 ft
d. 52.33 ft

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Math Problem Examples

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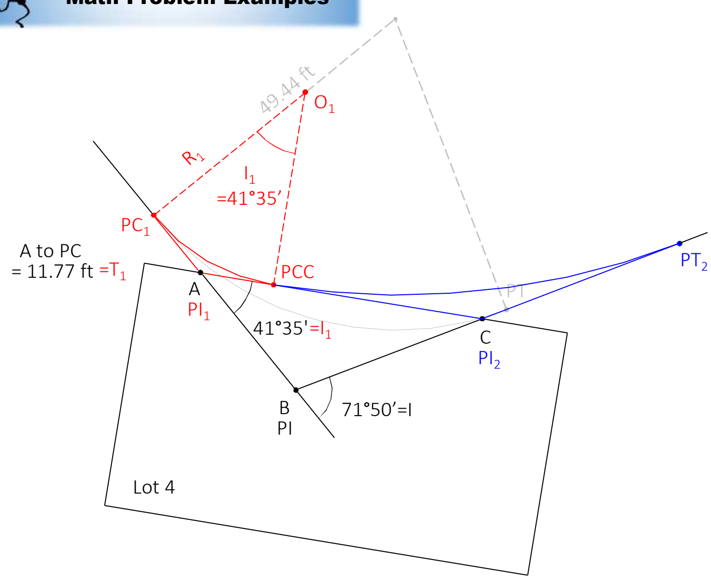

Part B.1 What is the radius of the first curve?

Lable the curve parts we know.

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Math Problem Examples

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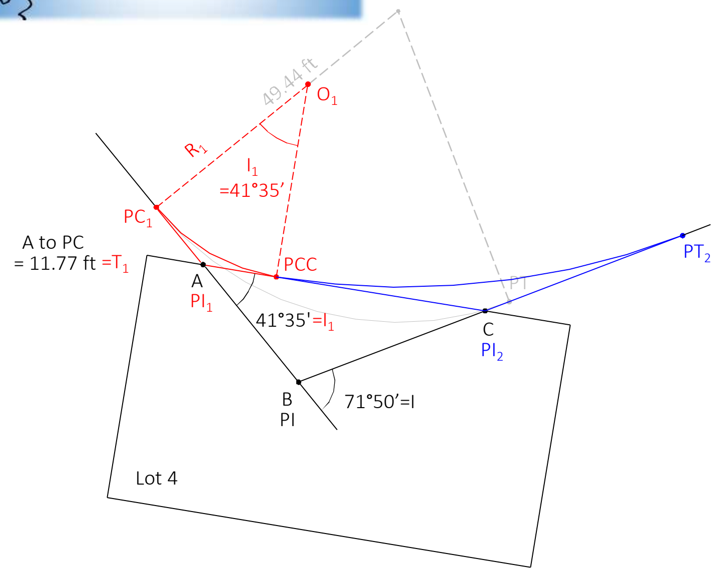

Part B.1 What is the radius of the first curve?

Lable the curve parts we know.

Compute the radius from the tangent distance.

$$T_1 = R_1 \times \tan\left(\frac{I_1}{2}\right)$$

$$R_1 = \frac{T_1}{\tan\left(\frac{I_1}{2}\right)} = \frac{11.77\text{ft}}{\tan\left(\frac{41°35'}{2}\right)}$$

$$= 30.998\text{ft} = \underline{31.00\text{ft}}$$

Answer: a. 31.00 ft

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Math Problem Examples

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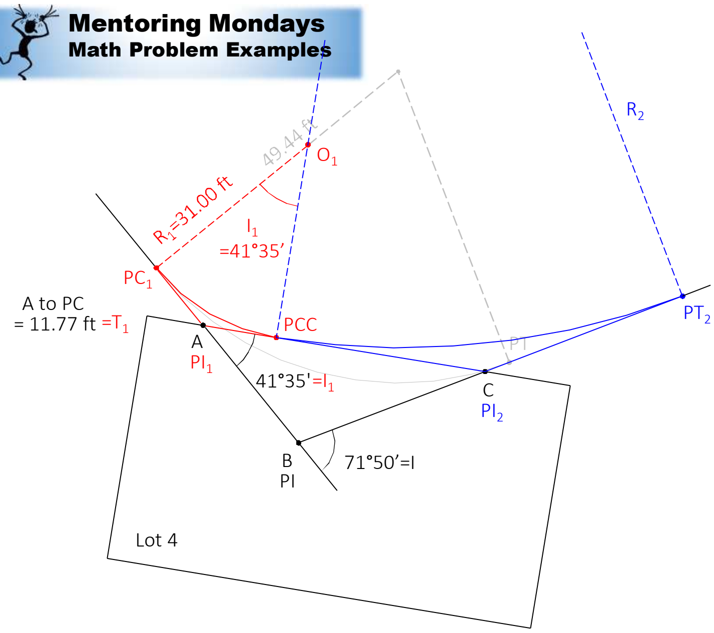

Part B.2 What is the radius of the second curve?

a. 121.35 ft
b. 122.30 ft
c. 123.25 ft
d. 124.20 ft

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Math Problem Examples

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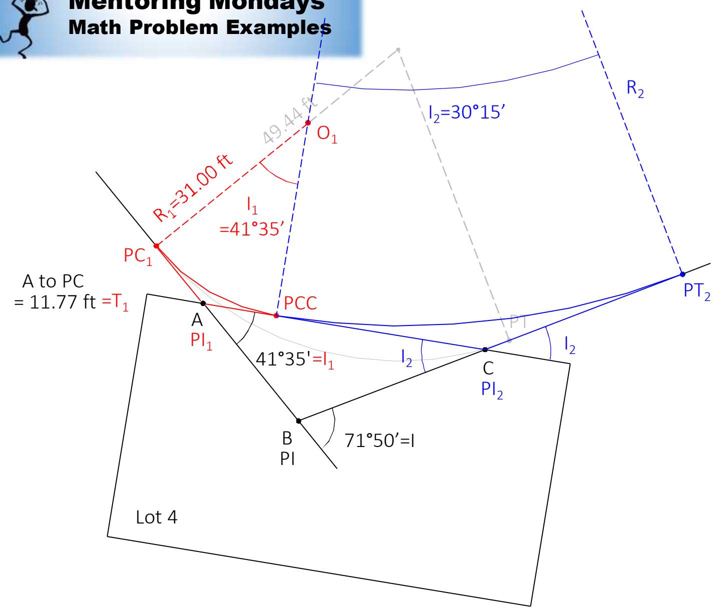

Part B.2 What is the radius of the second curve?

We need at least two parts of a curve to determine the remainder of its attibutes.

We can determine the I-angle for the second cuve:

$$I_2 = I - I_1 = 71°50' - 41°35' = 30°15'$$

We still need another piece.

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Math Problem Examples

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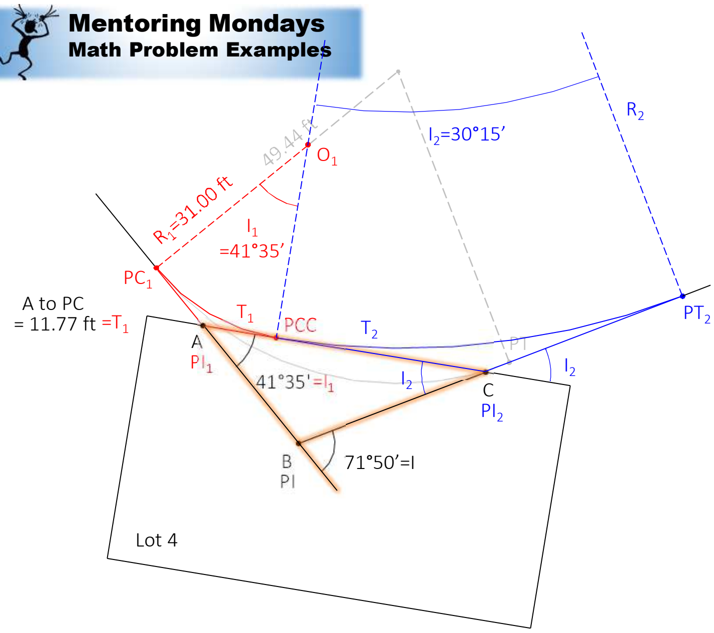

Part B.1 What is the radius of the first curve?

The three PIs define the *vertex triangle*.

Angle at PI is (180°-I)

Distance from PI_1 to PCC is T_1
Distance from PCC to PI2 is T_2

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Math Problem Examples

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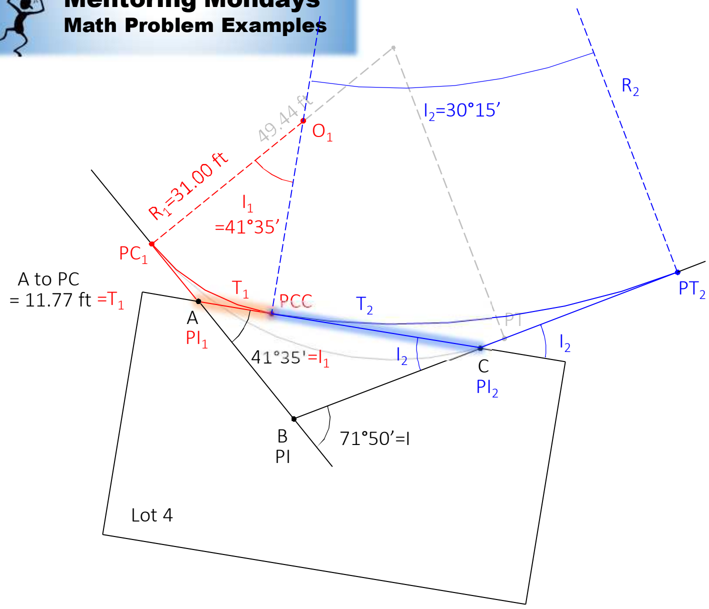

Part B.2 What is the radius of the second curve?

That piece is the tangent distance, T_2 which is ($AC-T_1$).

How to get AC?
In triangle ABC, we start with three angles:

I_1, I_2, $180°-(I_1+I_2)$

To solve AC, use Law of Sines:

$$\frac{AC}{\sin(180°-I_1-I_2)}=\frac{AB}{\sin(I_2)}=\frac{BC}{\sin(I_1)}$$

We don't have any sides ... or do we ...?

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Math Problem Examples

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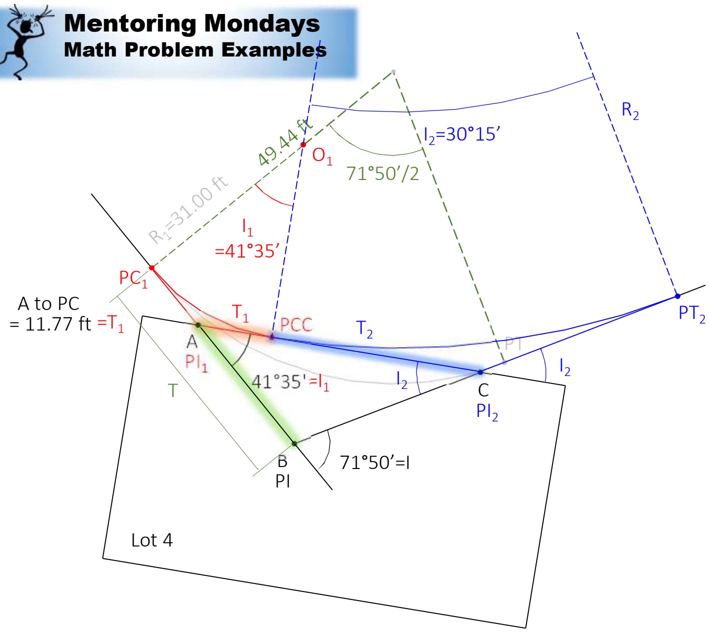

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To solve AC, use Law of Sines:

$$\frac{AC}{\sin(180°-I_1-I_2)}=\frac{AB}{\sin(I_2)}=\frac{BC}{\sin(I_1)}$$

We don't have any sides ... or do we ...?

$$\begin{aligned} AB &= T-T_1 \\ &= 49.44\text{ft}\times\tan\left(71°50'/2\right)-11.77\text{ft} \\ &= 35.81\text{ft}-11.77\text{ft}=24.04\text{ft} \end{aligned}$$

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Math Problem Examples

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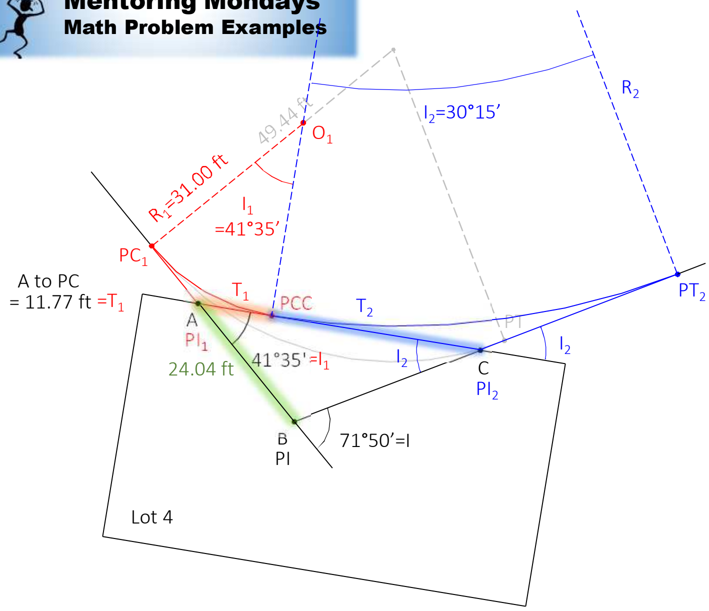

Part B.2 What is the radius of the second curve?

That piece is the tangent distance, T_2 which is ($AC-T_1$).

How to get AC?
In triangle ABC, we start with three angles:

I_1, I_2, 180°-(I_1+I_2)

To solve AC, use Law of Sines:

$$\frac{AC}{\sin(180° - 41°35' - 30°15')} = \frac{24.04ft}{\sin(30°15')}$$

$$AC = 24.04ft \times \frac{\sin(108°10')}{\sin(30°15')} = 45.34ft$$

Then: $T_2 = (45.34ft - 11.77ft) = 33.57ft$

So: $R_2 = \frac{T_2}{\tan\left(\frac{I_2}{2}\right)} = \frac{33.57}{\tan\left(\frac{30°15'}{2}\right)} = \underline{124.20ft}$

Answer: d. 124.20 ft

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Math Problem Examples

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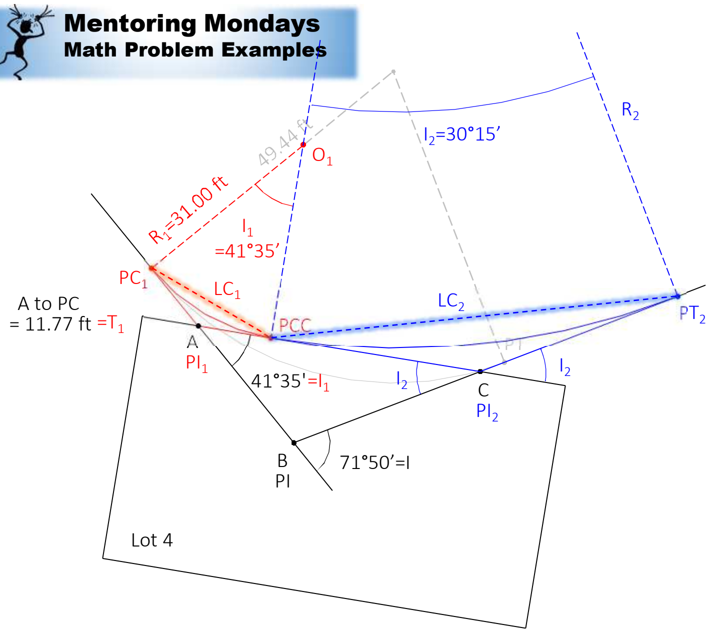

Part B.3 What are the long chords for both curves?

a. 20.18 ft and 50.43 ft
b. 20.18 ft and 64.21 ft
c. 22.01 ft and 64.81 ft
d. 23.89 ft and 64.81 ft

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Math Problem Examples

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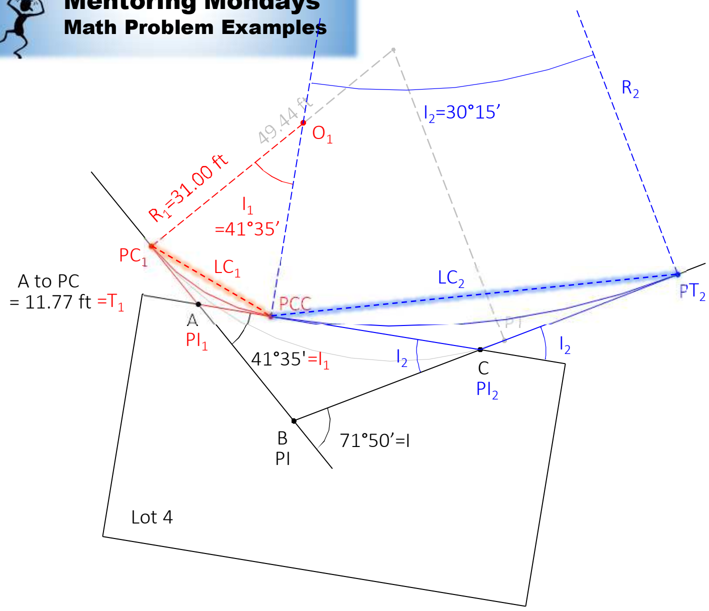

Part B.3 What are the long chords for both curves?

$$LC = 2R \times \sin\left(\frac{I}{2}\right)$$

$$LC_1 = 2(31.00\text{ft}) \times \sin\left(\frac{41°35'}{2}\right) = \underline{22.01\text{ft}}$$

$$LC_2 = 2(124.20\text{ft}) \times \sin\left(\frac{30°15'}{2}\right) = \underline{64.81\text{ft}}$$

Answer: c. 22.01 ft and 64.81 ft

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Math Problem Examples

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Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

a. 954.4 ft
b. 1090.4 ft
c. 1095.6 ft
d. 1243.2 ft

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Math Problem Examples

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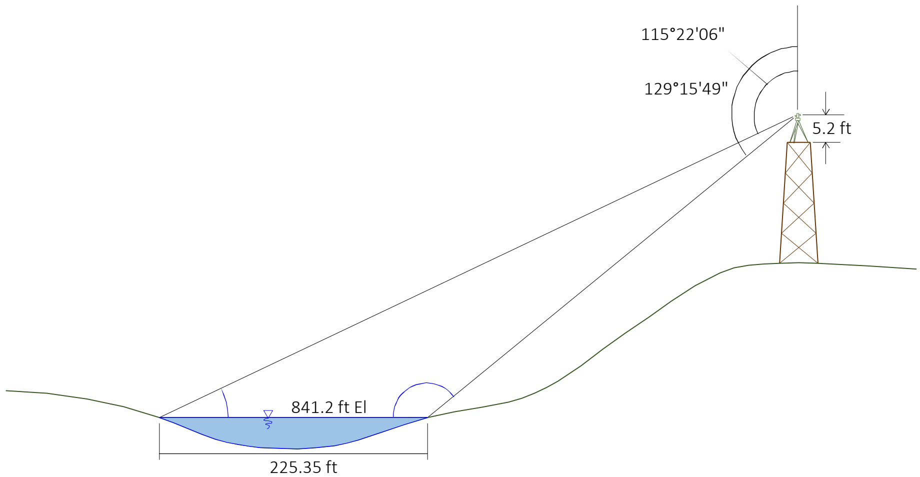
Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

Sketch



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Math Problem Examples

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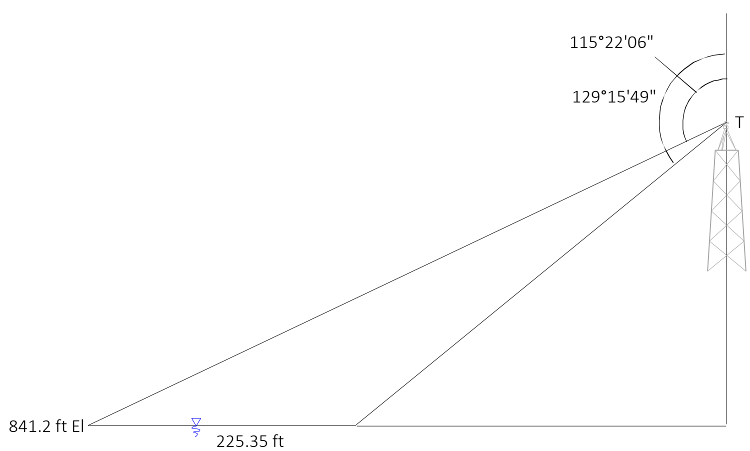
Sketch

Isolate triangles



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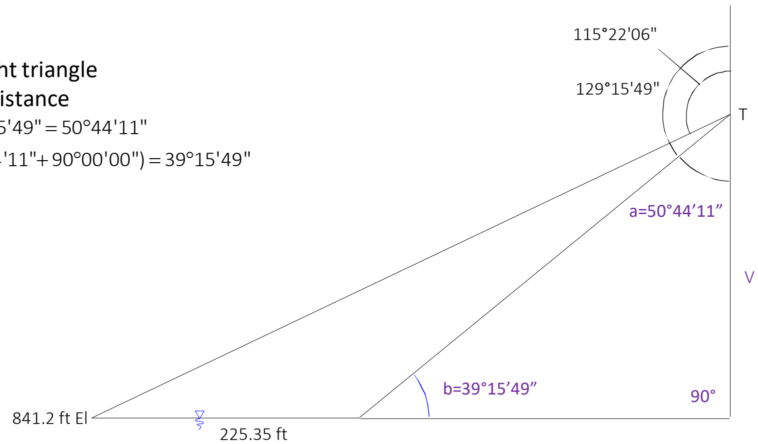
Comps

- Isolate triangles
- Compute angles in right triangle
  - V is the vertical distance

$a = 180°00'00" - 129°15'49" = 50°44'11"$

$b = 180°00'00" - (50°44'11" + 90°00'00") = 39°15'49"$



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Math Problem Examples

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Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

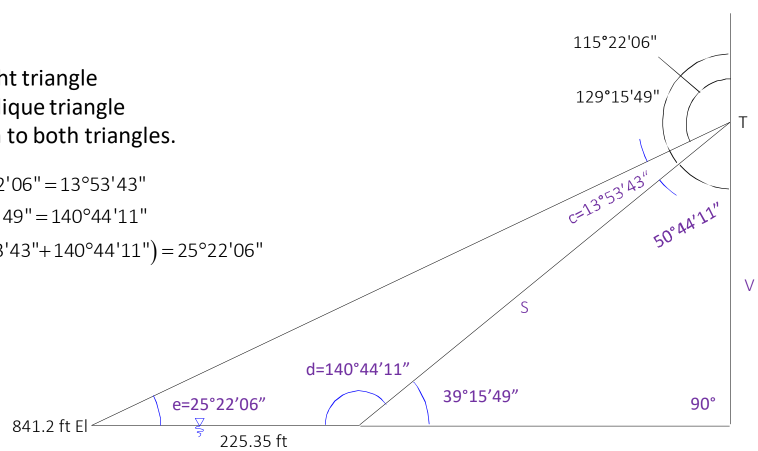
Comps

- Isolate triangles
- Compute angles in right triangle
- Compute angles in oblique triangle
  - Side S is common to both triangles.

$c = 129°15'49" - 115°22'06" = 13°53'43"$

$d = 180°00'00" - 39°15'49" = 140°44'11"$

$e = 180°00'00" - \left(13°53'43" + 140°44'11"\right) = 25°22'06"$



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Math Problem Examples

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Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

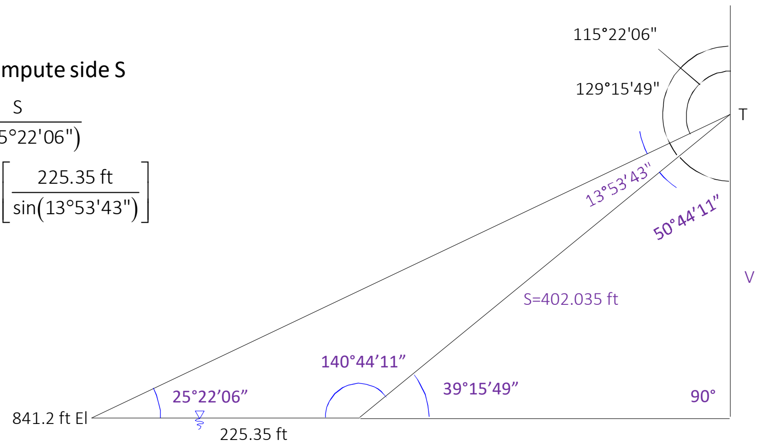
Comps

Use Law of Sines to compute side S

$$\frac{225.35\text{ ft}}{\sin(13°53'43")}=\frac{S}{\sin(25°22'06")}$$

$$\Rightarrow S=\sin(25°22'06")\times\left[\frac{225.35\text{ ft}}{\sin(13°53'43")}\right]$$

$$=402.035\text{ ft}$$



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Math Problem Examples

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Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

Comps

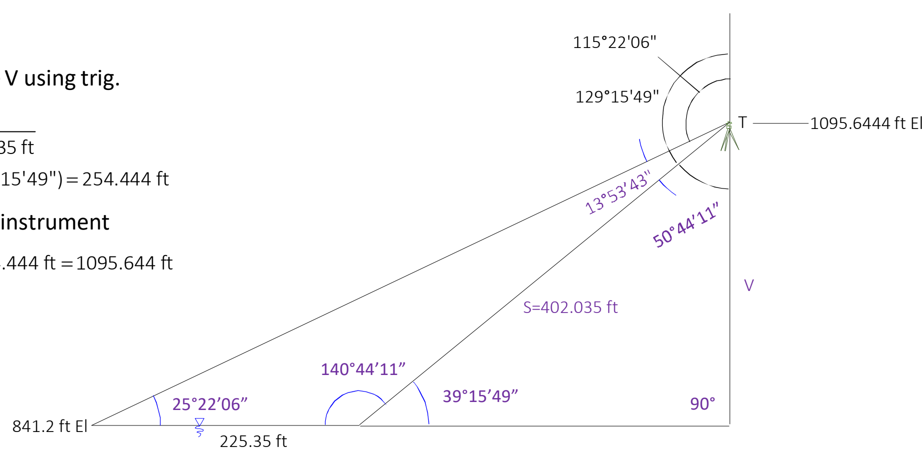
Solve vertical distance V using trig.

$$\sin(39°15'49")=\frac{V}{402.035\text{ ft}}$$

$$V=402.035\text{ ft}\times\sin(39°15'49")=254.444\text{ ft}$$

Compute elevation of instrument

$$\text{Elev}_T=841.2\text{ ft}+254.444\text{ ft}=1095.644\text{ ft}$$



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Math Problem Examples

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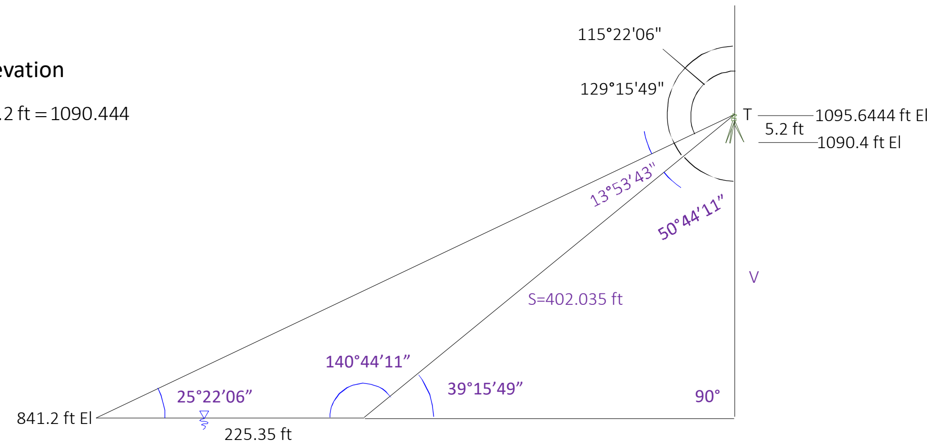
Problem C. Total station on lookout tower, inst ht 5.2 ft. 115°22'06" and 129°15'49" zenith angles to far & near sides of a river. Later, horiz dist between two river points meas'd as 225.35 ft. River elev: 841.2 ft. Tower elev?

Comps

Compute platform elevation

$$\text{Elev}_P = 1095.644 \text{ ft} - 5.2 \text{ ft} = 1090.444$$
$$= 1090.4 \text{ ft}$$

Answer: b. 1090.4 ft



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Math Problem Examples

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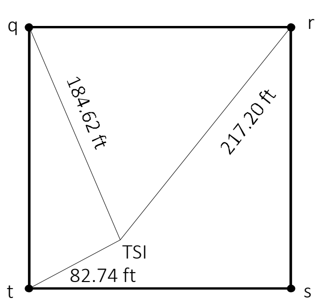
Problem D. A surveyor set up her total station instrument (TSI) at location from which she could see three corners of a square parcel. She measured horizontal distance to the three corners as shown below. What is the parcel's area to the nearest 10 square feet?

a. 15,520 sq ft
b. 28,060 sq ft
c. 35,450 sq ft
d. 43,530 sq ft



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Math Problem Examples

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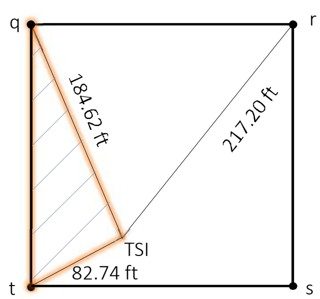

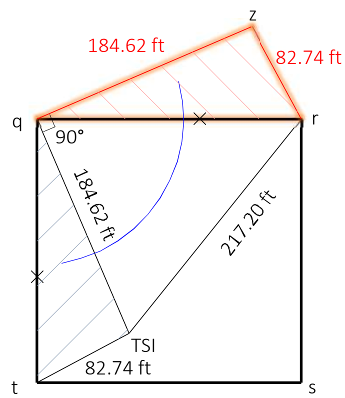

Rotate a copy of triangle q-t-TSI ccw about q so q-t coincides with q-r. This forms a smiliar triangle q-r-z

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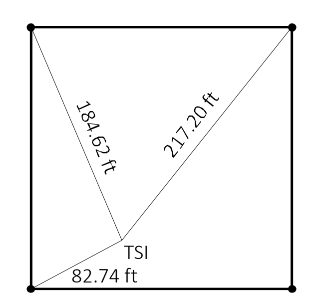
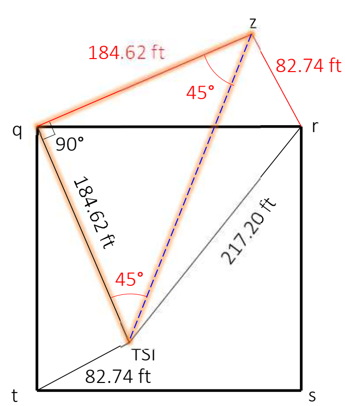
Math Problem Examples

Jerry Mahun 01 Nov 2021

Problem D. A surveyor set up her total station instrument (TSI) at location from which she could see three corners of a square parcel. She measured horizontal distance to the three corners as shown below. What is the parcel's area to the nearest 10 square feet?

a. 15,520 sq ft
b. 28,060 sq ft
c. 35,450 sq ft
d. 43,530 sq ft





Triangle q-z-TSI is a right isosceles triangle: angle q is 90°, angles z and TSI are 45°00'00".

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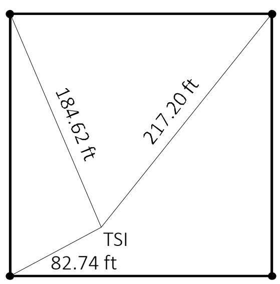

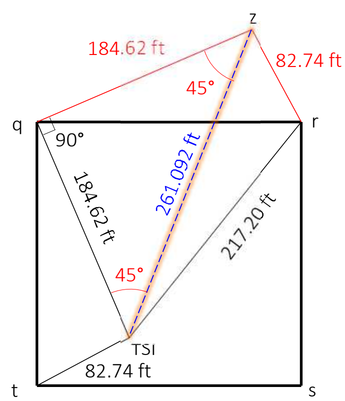

Triangle q-z-TSI is a right isosceles triangle: angle q is 90°, angles z and TSI are 45°00'00".

Solve side TSI-z using pythagorean theorem: 261.092 ft

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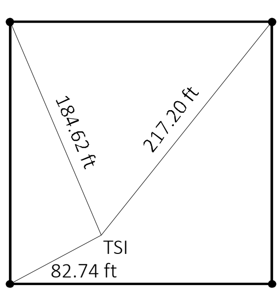

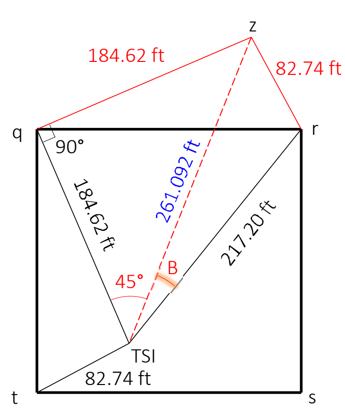

Solve angle B (at TSI) of triangle z-r-TSI using Law of Cosines: 16°56'12.9"

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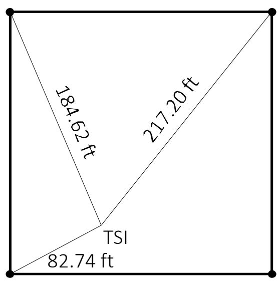

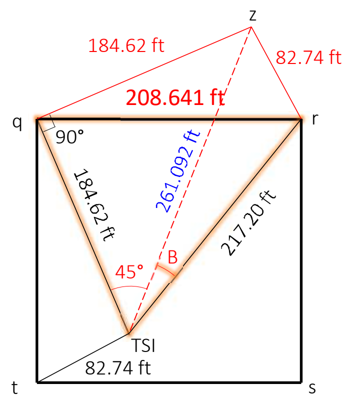

Solve q-r of triangle q-r-TSI using using Law of Cosines;

The angle at the TSI is
A+B = 45°00'00"+16°56'12.9"
=61°56'12.9"

q-r = 208.641 ft

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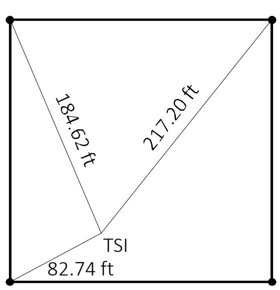

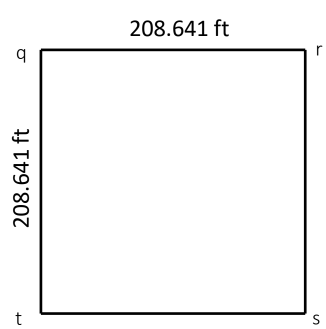

Since the parcel is square,
Area = 208.641 ft x 208.641
= 43.531.1
= 43,530 sf

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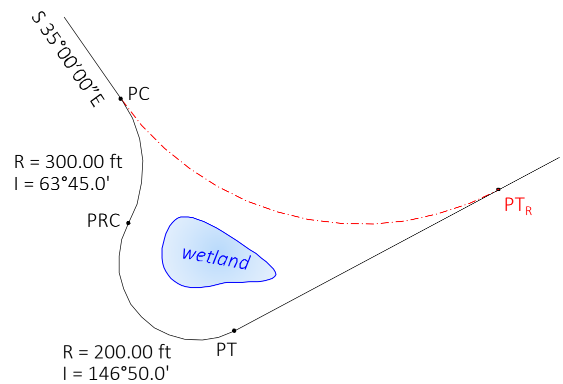
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

Part E.1. What is the radius, to the nearest 0.1 ft, of the replacement single curve?

a. 500.0 ft
b. 653.2 ft
c. 744.3 ft
d. 895.2 ft



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Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

Initial Comps

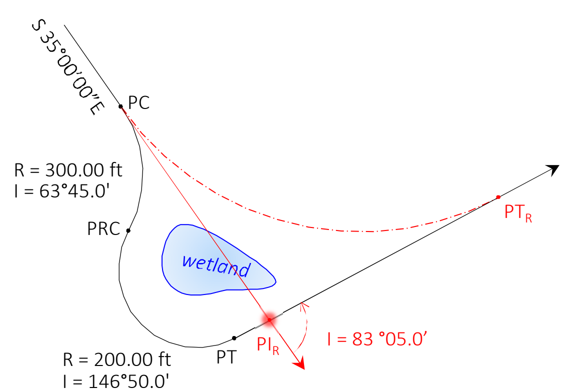
The I angle is the direction change from the incoming tangent to outgoint tangent

For the existing cuvres:

63°45.0'R + 146°50.0'L = 83°05.0'L = I

Need another curve attribute to fix its geometry.

Compute PI_R coordinates by COGO intersection
Inverse PC-PI_R to get tangent distance, R
Use I and T to compoute R



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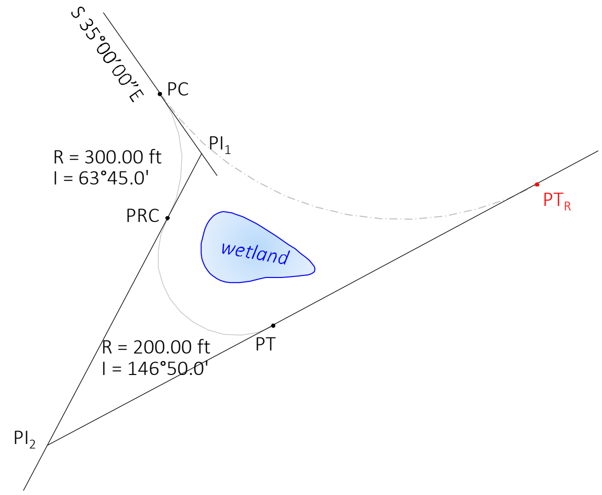
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

Azimuths:

$$Az_{PC-PI1} = 180°00'00" - 35°00'00" = 145°00'00"$$
$$Az_{PI1-PI2} = 145°00'00" + 63°45.0' = 208°45.0'$$
$$Az_{PI2-PT2} = 208°45.0' - 146°50.0' = 61°55.0'$$

Distances:

$$T_1 = 300.00\text{ ft} \times \tan\left(\frac{63°45.0'}{2}\right) = 186.552\text{ ft}$$
$$T_2 = 200.00\text{ ft} \times \tan\left(\frac{146°50.0'}{2}\right) = 671.600$$



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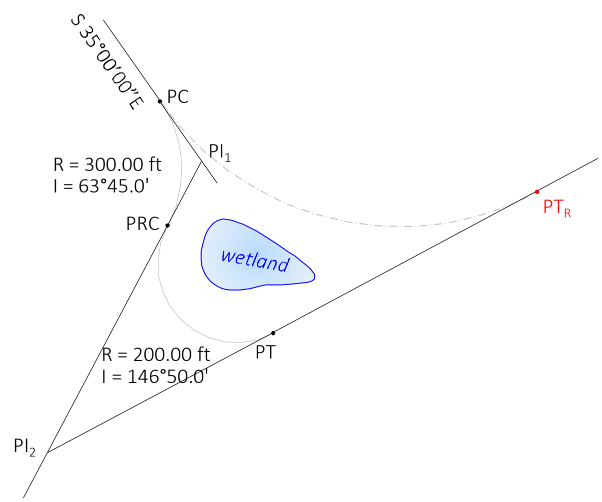
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

Starting with 2000.00 ft N and 1000.00 ft E for the PC and using the azumths and distances from the previous slide, the other coordinates are:

Point	*N (ft)*	*E (ft)*
PC	2000.00	1000.00
PI_1	1847.186	1107.002
PRC	1683.630	1017.272
PI_2	1094.821	694.24
PT	1410.980	1286.769



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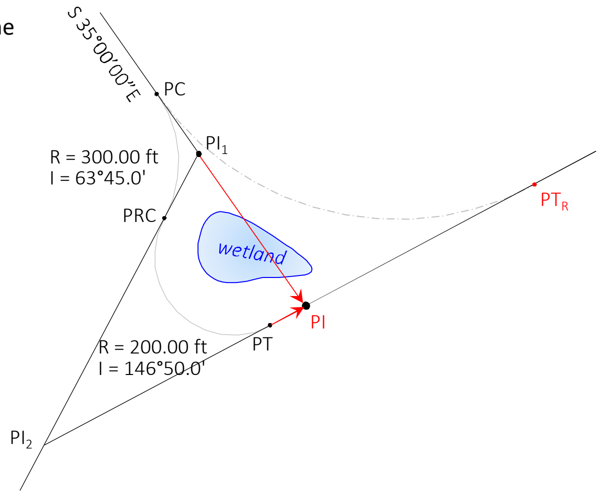
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

The PI of the new curve is located as the intersection of the incoming and outgoing tangents.
Its coordinates are cmpouted with a COGO direction-direction intersection.

Point	*N (ft)*	*E (ft)*
PI	1459.795	1378.256



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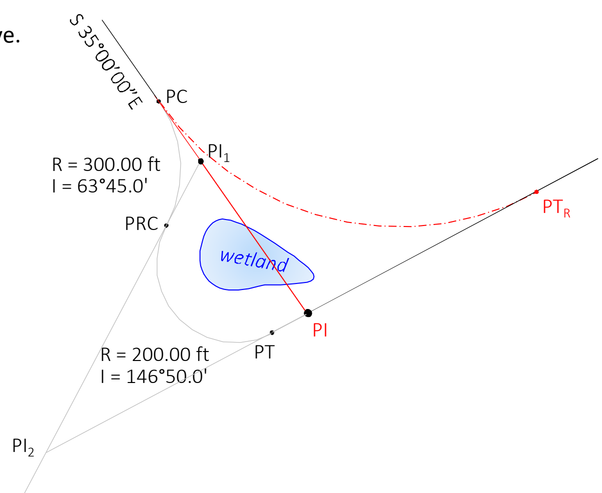
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

The distance PC-PI is the tangent distance of the new curve.
Inverse between coordinates to get the length: 659.468 ft

$$T_1 = R \times \tan\left(\frac{I}{2}\right)$$

$$\Rightarrow R = \frac{T}{\tan\left(\frac{I}{2}\right)} = \frac{659.48\text{ ft}}{\tan\left(\frac{83°05.0'}{2}\right)} = 744.315\text{ ft}$$

Answer: c. 744.3 ft



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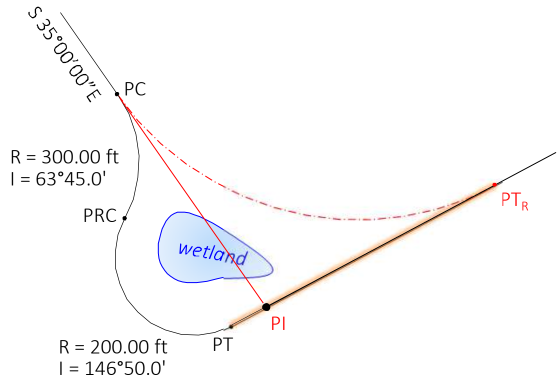
Problem E. A reverse curve along a road center line is to be replaced by a single tangent horizontal curve. The new curve must begin at the same PC but end at a new PT_R on the same outgoing tangent. The data shown is for the existing reverse curve situation.

Part E.2 What is the distance, to the nearest 0.1 ft, along the tangent from the old PT to the new PT_R?

a. 536.4 ft
b. 601.2 ft
c. 688.0 ft
d. 763.2 ft



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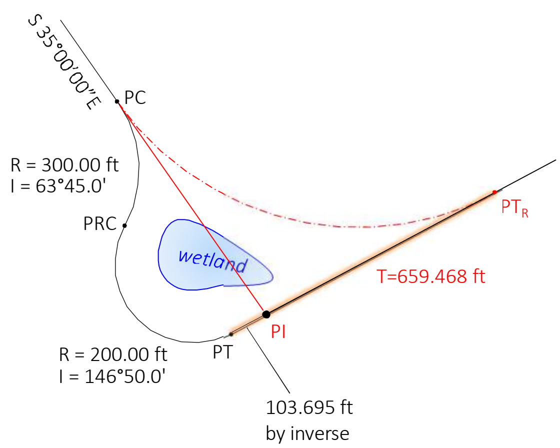
Part E.2 What is the distance, to the nearest 0.1 ft, along the tangent from the old PT to the new PT_R?

a. 536.4 ft
b. 601.2 ft
c. 688.0 ft
d. 763.2 ft

Dist = 103.695 ft + 659.468 ft = 763.163 ft
Answer: d. 763.2 ft



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Math Problem Examples

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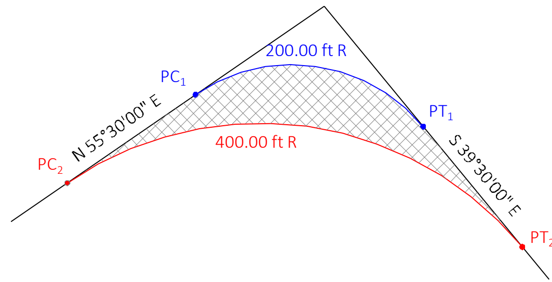
Problem F. To the nearest 10 square feet, what is the area between the two tangent circular arcs and tangent lines.

a. 20,950 sf
b. 29,770 sf
c. 118,680 sf
d. 139,630 sf



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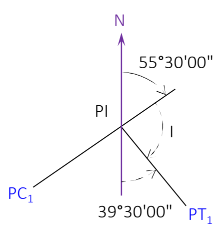
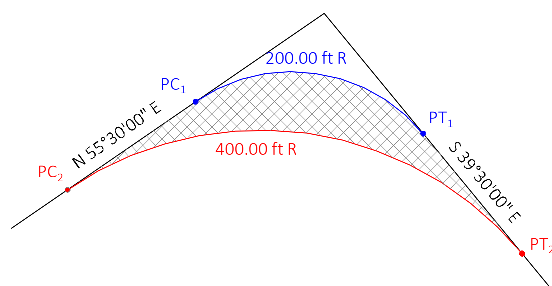
Problem F. To the nearest 10 square feet, what is the area between the two tangent circular arcs and tangent lines.

Preliminary comps:

determine I angle



$$I = 180°00'00'' - (55°30'00'' + 39°30'00'')$$
$$= 85°00'00''$$



tangent distances

$$T_1 = 200.00\text{ ft} \times \tan\left(\frac{85°00'00''}{2}\right) = 183.266\text{ ft}$$

$$T_2 = 400.00\text{ ft} \times \tan\left(\frac{85°00'00''}{2}\right) = 366.532\text{ ft}$$

$$T_2 - T_1 = 366.532\text{ ft} - 183.266\text{ ft} = 183.266\text{ ft}$$

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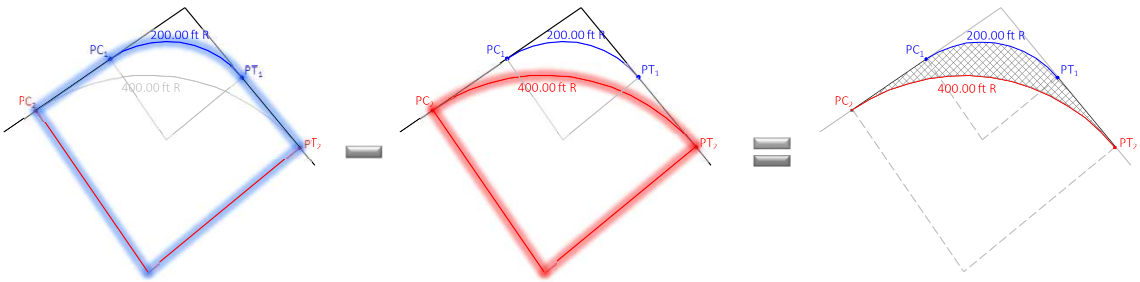
Problem F. To the nearest 10 square feet, what is the area between the two tangent circular arcs and tangent lines.

Solution Logic

1. Compute the area bounded by the 200.00 ft arc, tangents, and 400.00 ft radii.
2. Subtract the sector area of the 400'00 ft R arc.



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Problem F. To the nearest 10 square feet, what is the area between the two tangent circular arcs and tangent lines.

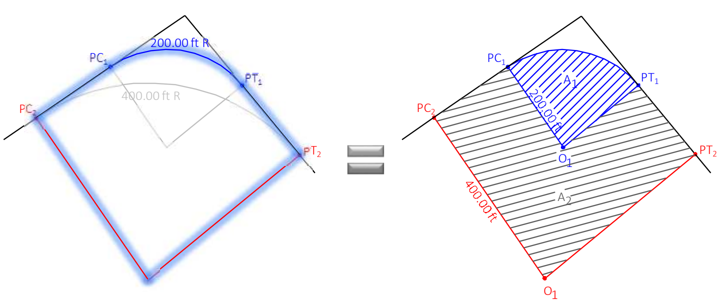
Solution Logic

1. Area bounded by the 200.00 ft arc, tangents, and 400.00 ft radii.

   This area is the sum of A_1 and A_2

   A_1 is the 200.00 ft R sector area

   A_2 is bounded by straight lines – compute by coordinates.



$$A_1 = \frac{85°00'00" \times \pi \times (200.00\text{ ft})^2}{360°}$$
$$= 29{,}670.6\text{ sf}$$

A_2 = 109,959.6 sf
(from coord comps; not shown)

A_1+A_2=139,630.2 sf

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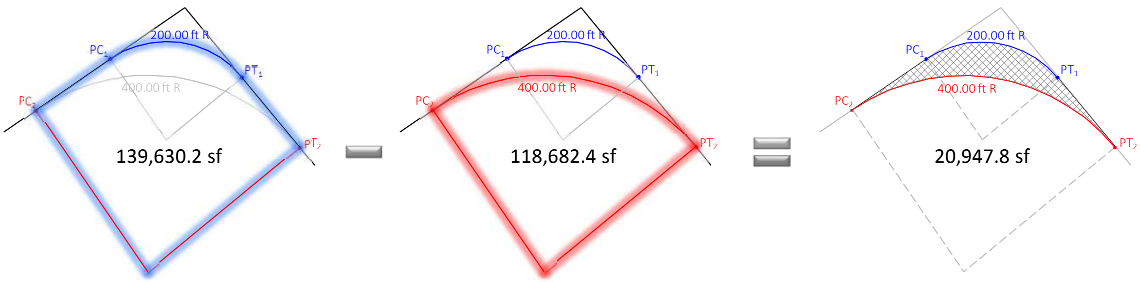
Problem F. To the nearest 10 square feet, what is the area between the two tangent circular arcs and tangent lines.

Solution Logic

1. Compute the area bounded by the 200.00 ft arc, tangents, and 400.00 ft radii.
2. Subtract the sector area of the 400'00 ft R arc.

$$A_3 = \frac{85°00'00" \times \pi \times (400.00\text{ ft})^2}{360°} = 118{,}682.4\text{ sf}$$



Answer: a. 20,950 sf