1. Given the following data for a highway curve to the left: $\Delta = 32^\circ 30' 00''$, $R = 1809.34'$, $T = 437.91'$, $L = 1026.32$, $LC = 1012.61$, $D = 03^\circ 10' 00''$ and the following table of deflections and chords:

<table>
<thead>
<tr>
<th>Station</th>
<th>Deflection</th>
<th>Sub-chord</th>
<th>Chord</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC 24 + 36.83</td>
<td>00° 00' 00''</td>
<td>0.00'</td>
<td>0.00'</td>
</tr>
<tr>
<td>25 + 00</td>
<td>01° 00' 01''</td>
<td>63.17</td>
<td>63.17</td>
</tr>
<tr>
<td>26 + 00</td>
<td>02° 35' 01''</td>
<td>99.99</td>
<td>163.12</td>
</tr>
<tr>
<td>27 + 00</td>
<td>04° 10' 01''</td>
<td>99.99</td>
<td>262.94</td>
</tr>
<tr>
<td>28 + 00</td>
<td>05° 45' 01''</td>
<td>99.99</td>
<td>362.57</td>
</tr>
<tr>
<td>29 + 00</td>
<td>07° 20' 01''</td>
<td>99.99</td>
<td>461.91</td>
</tr>
<tr>
<td>30 + 00</td>
<td>08° 55' 01''</td>
<td>99.99</td>
<td>560.90</td>
</tr>
<tr>
<td>31 + 00</td>
<td>10° 30' 01''</td>
<td>99.99</td>
<td>659.47</td>
</tr>
<tr>
<td>32 + 00</td>
<td>12° 05' 01''</td>
<td>99.99</td>
<td>757.53</td>
</tr>
<tr>
<td>33 + 00</td>
<td>13° 40' 01''</td>
<td>99.99</td>
<td>855.01</td>
</tr>
<tr>
<td>34 + 00</td>
<td>15° 15' 01''</td>
<td>99.99</td>
<td>951.84</td>
</tr>
<tr>
<td>PT 34 + 63.14</td>
<td>16° 15' 00''</td>
<td>63.14</td>
<td>1012.61</td>
</tr>
</tbody>
</table>

There are stakes in the ground at the PC, PI, and PT. In all questions relating to angles set or sighted, you must specify telescope position.

A. There are no obstructions to prevent setting out stakes from the PC as far as station 28 + 00 with your electronic total station. How will you set a stake at station 28 + 00? Be specific in terms of angle set for the back sight, where the back sight is, and angle set for pointing at 28 + 00. Also, what distance you will measure to 28 + 00 and where you will measure this distance from?

B. You must set the location of catch basins at station 30 + 50. What is the deflection angle for station 30 + 50? You may measure to 30 + 50 from either the PC or station 30 + 00. What are the chord lengths to 30 + 50 from the PC and from 30 + 00?

C. You have been able to stake out stations from the PC as far as 30 + 00, but must now move your total station to station 30 + 00 to stake out the rest of the curve. How will you stake out station 31+ 00? Be specific in terms of angle set for the back sight, where the back sight is, and angle set for pointing at 31 + 00. Also, what distance you will measure to 31 + 00 and where you will measure this distance from?

D. Assume that Station 32 + 00 is the low point of a curve and consequently catch basins are to be installed at this station. While you are set at this station (which you set out from station 30 + 00), you will stake out the position of the catch basins. The pavement is to be 30 feet wide. If you must sight on 30 + 00, how will you do this? Be specific in terms of angle set for the back sight, where the back sight is, and angle set for pointing toward the catch basin locations. Also, what distance you will measure to the catch basin locations, and where you will measure this distance from?

E. From station 30 + 00, you are able to stake out stations as far as 33 + 00, but not beyond 33 + 00. How will you stake out station 34 + 00? Be specific in terms of angle set for the back sight, where the back sight is, and angle set for pointing at 34 + 00. You cannot sight any stations from the PC through Station 30 + 00. Also, what distance you will measure to 34 + 00 and where you will measure this distance from?
1.A. Total Station @ PC. - Sight 00° 00' 00", telescope inverted, back along tangent line OR
Sight 00° 00' 00", telescope normal, on PI. Now set 05° 45' 01" LEFT, and with telescope in the
normal position, instrument is pointed along the line of the chord from the PC to station 28 + 00.
Measure 362.57" along this line from the instrument to a prism and set a stake at 28 + 00.

1.B. Two possible solutions. Noting that D = 03° 10' 00", the deflection for 50' is D/4 = 00° 47' 30".
Add this to the deflection for 30 + 00 to get 09° 42' 31" for the deflection for 30 + 50. Add D/4 to this
to check the computation by finding that the 31 + 00 deflection is 10° 30' 01" as shown in the table of
deflections given. Second method is to simply average the 30 + 00 and 31 + 00 deflections as 30 +
50 is equidistant from each of them. That average is 09° 42' 31" as computed above. Chord length
for 30 + 00 to 30 + 50 is 2R sin D/4 = 49.998', effectively 50.00' for the nearest hundredth measuring
we are capable of. Chord length from PC to 30 + 50 is 2Rsin 09° 42' 31" = 610.25'.

1.C. Total Station @ 30 + 00. - Sight 00° 00' 00", telescope inverted on the PC. Now place the
telescope in the normal position, set 10° 30' 01" LEFT and measure 99.99' along that line from the
instrument to set a stake at 31 + 00.

1.D. Total Station @ 32 + 00. - Set 03° 10' 00" RIGHT, telescope normal, on 30 + 00. Now set 90°
00' 00" RIGHT and with the telescope normal, measure along that line 15' to set the inner
catch basin. Then invert the telescope and measure 15' along that line to set the outer catch
basin. Alternatively, for the inner catch basin, you may set 90° 00' 00" LEFT or 270° 00' 00"
RIGHT, telescope normal. An alternative method is to sight 00° 00' 00", telescope normal, on
the PC, then set 93° 10' 00" LEFT, telescope normal, and measure along that line 15' to set
the outer catch basin, invert the telescope and measure 15' to the inner catch basin. You may
instead, sight 00° 00' 00", telescope normal, on the PC, then set 86° 50' 00" RIGHT, telescope
normal, and measure along that line 15' to set the inner catch basin, invert the telescope and
measure 15' to the outer catch basin.

1.E. Total Station @ 33 + 00. - Sight 08° 55' 01" LEFT, telescope inverted, on 30 + 00. Invert the
telescope to the normal position, set 15° 15' 01" LEFT and measure 99.99', along that line, from the
instrument, to set a stake at 34 + 00.
F. Sketch the curve, and indicate by a small triangle symbol on the sketch each of the stations you set the instrument to accomplish items A through E, above.
2. A horizontal circular curve must be shifted from its original location to miss an obstruction. The original curve to the right is defined by its central angle of $95^\circ 00' 00"$ and its long chord of 490.00'. The new curve is established by moving the rearward or backward tangent inward 15.00', parallel to the original rearward tangent, without changing the position of the P.T. **Compute the new curve long chord and radius.** You should be able to solve this problem more than one way so that you can have a check of your solution, and therefore be confident that it is correct. A sketch is essential to earn full credit for this problem.

![Diagram of circular curve](image)

(1) **LC change**

$$ \frac{LC_{\text{change}}}{\text{in} 47^\circ 30'} = 15 $$

New $LC = 490.00 - 20.35 = 469.65$

$$ LC_2 = \frac{2\times \tan 47^\circ 30'}{2\times \sin 85^\circ} $$

$$ 469.65 = 2R_2 \sin 47^\circ 30' $$

$$ R_2 = 318.50 $$

(2) **continued**

$$ R_1 = \frac{LC_1}{2\sin 47^\circ 30'} = \frac{490}{2\sin 47^\circ 30'} = 332.30 $$

$$ T_1 = 332.30 \times \tan 47^\circ 30' = 362.65 $$

$$ T_2 = T_1 - \tan \text{change} = 362.65 - 15.06 = 347.59 $$

$$ R_2 = \frac{347.59}{\tan 47^\circ 30'} = 318.51 $$

$$ LC_2 = 2(318.51) \sin 47^\circ 30' = 469.66 $$

**.50 round off error**