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## SECTION A

### SOLUTIONS TO TEXT PROBLEMS

## CHAPTER 2

2.1 a)  $c+r = .0206 \times (800/1000)^2 = 0.013 \text{ ft.}$

b)  $c+r = .0206 \times 4^2 = 0.33 \text{ ft.}$

c)  $c+r = .0675 \times (700/1000)^2 = 0.033 \text{ m}$

d)  $c+r = .574 \times 1.5^2 = 1.29 \text{ ft.}$

e)  $c+r = .0675 \times 2.5^2 = 0.422 \text{ m}$

f)  $c+r = .0675 \times 3^2 = 0.608 \text{ m}$

2.2 a) i 2.05	b) i 1.165	c) i 2.05	d) i 1.085	e) i 3.10	f) i 1.165
ii 1.90	ii 1.120	ii 1.79	ii 1.005	ii 2.82	ii 1.045
iii 1.56	iii 1.020	iii 1.45	iii 0.970	iii 2.54	iii 0.990
iv 1.20	iv 0.960	iv 1.25	iv 0.940	iv 2.26	iv 0.915
v 0.90	v 0.910	v 0.95	v 0.900	v 1.98	v 0.860

2.3  $5.67 = 0.574 K_1^2$ ,  $K_1 = \sqrt{5.67/0.574} = 3.143 \text{ miles}$

$230 = 0.574 K_2^2$ ,  $K_2 = \sqrt{230/0.574} = 20.017 \text{ miles}$

Maximum visibility distance  $(K_1+K_2) = 23.16 \text{ miles.}$

2.4	STATION	BS	HI	FS	ELEVATION
	BM 50	1.27	183.95		182.68
	TP 1	2.33	181.37	4.91	197.04
	TP 2			6.17	175.20
	$\Sigma \text{ BS} = 3.60$		$\Sigma \text{ FS} = 11.08$	$182.68 + 3.60 - 11.08 = 175.20 \text{ check}$	

2.5	STATION	BS	HI	IS	FS	ELEVATION
	BM 61	4.72	218.44		213.72	
	0+00		4.42		214.02	
	0+50			4.30		214.14
	TP 1	5.11	221.54	2.01	216.43	
	1+00			4.66		216.88
	1+50			3.98		217.56
	1+75			1.20		220.34
	TP 2				1.80	219.74
	$\Sigma \text{ BS} = 9.83$		$\Sigma \text{ FS} = 3.81$	$213.72 + 9.83 - 3.81 = 219.74 \text{ check}$		

2.6	STATION	BS	HI	FS	ELEVATION
	BM 3	1.613	134.618		133.005
	TP 1	1.425	134.116	1.927	132.691
	TP 2	1.307	133.713	1.710	132.406
	TP 3	1.340	133.780	1.273	132.440
	BM 3			0.780	133.000
	$\Sigma \text{ BS} = 5.685$		$\Sigma \text{ FS} = 5.690$	$133.005 + 5.685 - 5.690 = 133.000 \text{ check}$	

2.7 Error =  $133.005 - 133.000 = 0.005 \text{ m}$

2nd order Class 1 (U.S.) =  $6 \text{ mm} \sqrt{K} = .006 \sqrt{0.7} = .005$

2nd order (Canada) =  $8 \text{ mm} \sqrt{K} = .008 \sqrt{.7} = .007$ . The error qualifies for 2nd order in both countries.

2.8	STATION	BS	HI	FS	ELEVATION
	BM 100	2.71	144.15		141.44
	TP 1	3.62	142.89	4.88	139.27
	TP 2	3.51	142.43	3.97	138.92
	TP 3	3.17	142.79	2.81	139.62
	TP 4	1.47	142.64	1.62	141.17

BM 100 1.21 141.43  
 $\Sigma BS = 14.48 \quad \Sigma FS = 14.49$   
 $141.44 + 14.48 - 14.49 = 141.43 \text{ check}$

2.9 Error =  $141.44 - 141.43 = 0.01 \text{ ft.}$  2nd order allowable error =  $.035 \sqrt{1000/5280} = 0.015$   
 Therefore the results qualify for second order – according to Table 2.2.

2.10

STATION	BS	HI	IS	FS	ELEVATION
BM S101	0.475	172.320			171.845
0+000				0.02	172.30
0+020				0.41	171.91
0+040				0.73	171.59
0+060				0.70	171.62
171.594				0.726	171.594
0+080				1.38	170.94
0+100				1.75	170.57
0+120				2.47	169.85
TP 1	0.666	169.993			2.993 169.327
0+140				0.57	169.42
0+143.78			0.634		169.359
0+147.02			0.681		169.312
0+160				0.71	169.28
0+180				0.69	169.30
0+200				1.37	168.62
TP 2	0.033	168.321	1.705		168.288
BM S102			2.891		165.430
$\Sigma BS = 1.174$		$\Sigma FS = 7.589$		$171.845 + 1.174 - 7.589 = 165.430 \text{ check}$	

2.11

STATION	BS	HI	IS	FS	ELEVATION
BM 41	6.21	321.09			314.88
TP 13	4.10	324.30		0.89	320.20
12+00					
50 ft. left			3.9		320.4
18.3 ft. left				4.6	319.7
6				6.33	317.97
20.1 ft. right				7.9	316.4
50 ft. right				8.2	316.1
13+00					
50 ft. left			5.0		319.3
19.6 ft. left				5.7	318.6
6				7.54	316.76
20.7 ft. right				7.9	316.4
50 ft. right				8.4	315.9
TP 14	7.39	330.57		1.12	323.18
BM S22				2.41	328.16
$\Sigma BS = 17.70$		$\Sigma FS = 4.42$		$314.88 + 17.70 - 4.42 = 328.16 \text{ check}$	

2.12

Station	BS	HI	FS	Elevation	Left	6	Right
BM 107	7.71	240.37		232.66			
					60'	28'	0'
						32	60'

80+50			9.7	8.0	5.7	4.3	4.0
			230.7	232.4	234.7	236.1	236.4
81+00			60'	25'	0'	30'	60'
			10.1	9.7	6.8	6.0	5.3
			230.4	230.7	233.6	234.4	235.1
81+50			60'	27'	0'	33'	60'
			11.7	11.0	9.2	8.3	8.0
			228.7	229.4	231.2	232.1	232.4
TP 1	10.17	230.20					

- 2.13 a) Correct difference in elevation =  $8.72 - 5.61 = 3.11$  ft.  
b) Correct reading @ A would have been  $5.42 + 3.11 = 8.53$  ft.  
c) Error is  $(8.57 - 8.53) = +0.04$  ft. in 300 ft.  
d) Upper/lower reticle capstan screws are loosened/tightened until the cross hair falls on 8.53 on the rod @ A.

- 2.14 a)  $V = 148.61 \sin 21^\circ 26' = 54.30$  ft.  
Elevation of lower station =  $324.28 + 4.66 - 54.30 - 4.88 = 269.76$  ft.  
b)  $H = 148.61 \cos 21^\circ 26' = 138.33$  ft.  
Lower station =  $110 + 71.25 + 138.33 = 112 + 09.58$

- 2.15 a) First elevation difference =  $2.417 - 0.673 = 1.744$   
Second elevation difference =  $2.992 - 1.252 = 1.740$   
Average elevation difference =  $1.742$   
Elevation of B =  $187.298 - 1.742 = 185.556$  m  
b) Levelling error =  $0.004$  m

- 2.16 a) Error =  $167.174 - 167.185 = -0.011$  m  
Accuracy limit for 2nd order =  $0.007 \sqrt{8} = .006$   
Accuracy limit for 3rd order =  $0.012 \sqrt{8} = .011$  (U.S.)  
or =  $0.024 \sqrt{8} = .021$  (Canada)  
(See Tables 2.1 and 2.2)  
Therefore the error of  $-0.011$  satisfies the requirements for 3rd order accuracy in both the U.S. and Canada.

2.16 b)

Station	Cumulative	Elevation	Elevation Correction	Adjusted	Distance
BM 130		168.657		168.657	
TP 1	130	168.248	$130/780 \times 0.011 = +.002$	168.250	
TP 2	260	168.539	$260/780 \times 0.011 = +.004$	168.543	
TP 3	390	166.318	$390/780 \times 0.011 = +.006$	165.324	
BM K110	520	166.394	$520/780 \times 0.011 = +.007$	166.401	
TP 4	650	166.579	$650/780 \times 0.011 = +.009$	166.588	
BM 132	780	167.618	$780/780 \times 0.011 = +.011$	167.629	

$C = 167.629 - 167.618 = -0.011$   
The adjusted elevation of BM K110 is 166.401 m