# Exercises - Fundamentals of Geodesy

**5.** **Solving problem 4 in reverse is not easy. Two methods are 1) follow a lengthy procedure which has an iteration built-in (see equations 1-14 on page 20) or 2) solve the latitude equation by iteration (iteration is when you use the answer to a problem to solve it again).**

$$\tan\lambda = \frac{Y}{X}; \quad \tan\phi = \frac{Z}{\sqrt{X^2+Y^2}}\left(1+\frac{e^2 N \sin\phi}{Z}\right); \quad h = \frac{\sqrt{X^2+Y^2}}{\cos\phi} - N$$

**Given the following geocentric X/Y/Z coordinates, find $\phi$, $\lambda$, h on the NAD83.**

**X = 605,848.948 m** **$\phi$ =**

**Y = -4,882,630.368 m** **$\lambda$ =**

**Z = 4,045,539.709 m** **h =**

**6.** **One of the simplest equations used in surveying is $L = R\theta$ which says the arc length equals the radius times the subtended angle in radians (1 radian is defined as an angle whose arc length equals its radius). Several useful relationships are that there are $2\pi$ radians per circle ($\pi$ radians = 180°) and 206,264.8062470964 seconds of arc (enough digits for double precision) per radian. When used over short distances (less than 200 meters) geodetic positions (coordinates) can be related to plane surveying latitudes and departures using:**

$$Lat = M\,\Delta\phi = Dist\cos Az \quad while \quad Dep = N\cos\phi\,\Delta\lambda = Dist\sin Az$$

**If the latitude and longitude of point A are 42° 34' 15."44345 N and 271° 45' 16."88976 E and the distance & direction to point B is N 23° 15' 45" W 158.435 meters, what are the latitude and longitude of point B? What is answer if distance is 1,584.35 meters?**

**7.** **As in part 2 of problem 6, Clairaut's Constant is used to update the azimuth when traversing a geodetic line. What is the azimuth, $\alpha$, of a geodetic line at point 2 ($\phi$ = 43° 34' 45") if the geodetic line azimuth at point 1 ($\phi$ = 43° 10' 21") is 57° 41' 42"?**

**$K = N_1 \cos\phi_1 \sin\alpha_1 = N_2 \cos\phi_2 \sin\alpha_2$ = Clairaut's Constant**

**8.** **Given the data below, what is:**

- **the NGVD29 elevation for Point 2? Give an estimate of its accuracy.**
- **the NAVD88 elevation for Point 2? Give an estimate of its accuracy.**

| Point 1 | Point 2 |
|---|---|
| $\phi$ = 34° 25' 43."4465 N | $\phi$ = 34° 26' 09."8423 N |
| $\lambda$ = 82° 38' 31."8723 W | $\lambda$ = 82° 37' 55."3422 W |
| h = 243.225 m | h = 256.437 m |
| N = -30.193 m (GEOID96) | N = -30.216 m (GEOID96) |
| Datum diff = -0.110 m | Datum diff = -0.111 (VERTCON) |
| NGVD29 Elevation = 273.534 m (First-order BM) | |

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