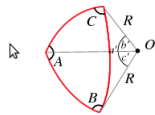
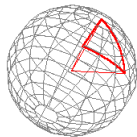


1 Spherical Triangle (30 points)



The area of a spherical triangle is given by the following equation:

$$\Delta = R^2[(A + B + C) - \pi] = R^2 E \quad (1)$$

where R stands for the radius of the sphere, A, B, C are the angles at the corners, and E is called the spherical excess. The figure is taken from WolframMathWorld.

(a) The file `spherical_triangle.m` defines a function `spherical_triangle` which takes `A, B, C` and `R` as input arguments, and returns the area Δ , using variable `Area`, and the excess E as output. We ask you to write the formulas above in the body of the function. (20 points)

(b) Let's think of a specific spherical triangle described as follows: One of the corners is the North pole, and the other two lie on the equator. Can you fill in the script `special_triangle.m` according to the instructions within? (10 points).

You can test your code by running `test_triangle.m`. You should upload files `spherical_triangle.m` and `special_triangle.m` to the CMS.

2 Distance (40 points)

The distance between two points A and B , in three dimensions, can be computed using their cartesian coordinates:

$$d_{AB} = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2 + (z_A - z_B)^2}$$

(a) Write a function called `distance` which takes 6 input variables, `xA, xB, yA, yB, zA, zB`, and returns the distance `dAB`. (10 points).

The area of a triangle ABC can be computed using Heron's formula,

$$Area = \sqrt{s(s - d_{AB})(s - d_{BC})(s - d_{CA})} \quad \text{where} \quad s = (d_{AB} + d_{BC} + d_{CA})/2$$

(b) Write a function called `triangle_area` which takes 9 input variables which are the coordinates for points A, B, C . It should return `Area, dAB, dBC` and `dCA`. (20 points)

(c) Complete the script `test_ABC.m` which tests these functions. (10 points).

You should upload three files named `distance.m`, `triangle_area.m` and `test_ABC.m` to the CMS.

3 Distance Converter (30 points)

Given that one mile is 1.60934 kilometers, write a distance converter between miles and kilometers. You should complete the file `distance_converter.m` and upload it to the CMS. (30 points)

4 Setun Returns (♥ 10 points)

There are 10 types of people in the world; those who understand binary, and those who don't. ☺

- (a) How many different characters can we represent using a single byte? (5 points)
- (b) If we had a ternary computer using digits $\{0, 1, 2\}$, how many *trits* would be required to represent all those characters? (5 points)

You should upload a file to the CMS named `setun.txt` which contains your answers. This is a bonus question.

5 Soccer Ball Toss (♥ 20 points)

You work for a company *WhatAreTheOdds* and you are assigned to design a function to simulate a toss using a soccer ball. A soccer ball contains 12 pentagons and 20 hexagons which looks like a truncated icosahedron on a sphere. The pentagons are in black and hexagons are in white color. A soccer ball toss results in a black B or white W depending on the color of point on the ball where it hits the ground after a toss. You need to compute the odds for B and W to simulate a soccer ball toss.

- (a) Write a function called `coin_toss` to simulate a fair coin toss which returns 0 for heads and 1 for tails. (10 points)
- (b) Write a function called `ball_toss` to simulate a soccer ball toss which returns 0 for black and 1 for white. (10 points) (Hint: Spherical Triangle)

You should upload two files named `coin_toss.m` and `ball_toss.m` to the CMS. This is a bonus question.