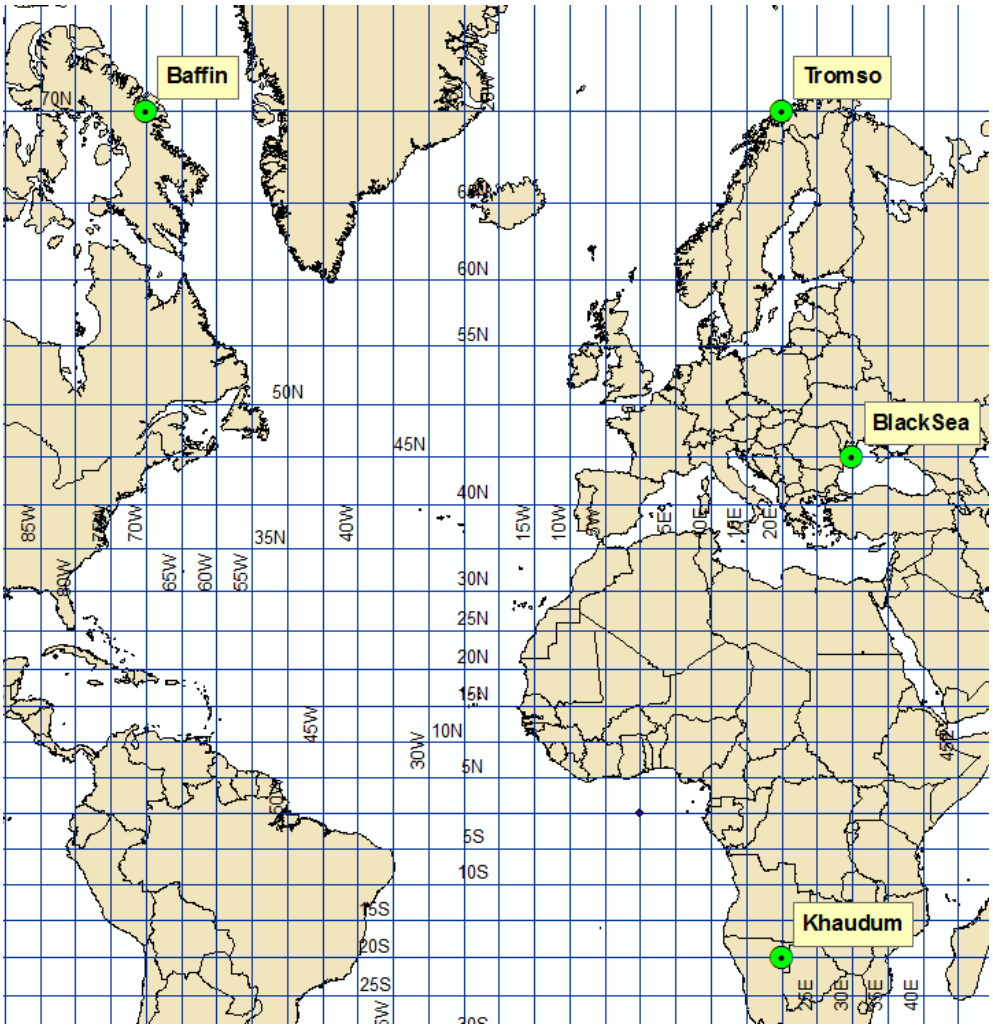
Part 1
Use the Mercator forward and inverse formulas to calculate the Mercator projection x and y coordinates for points 1 through 6 listed below. Use a radius for the Earth of 6,371,000 meters. Note that the central meridian changes for points 5 and 6.

The first row contains a worked example for point 1.

point	name	longitude	latitude	forward x	forward y	earth radius	central merid	inverse lat	inverse lon
1	BlackSea, Danube	30	45	3,335,848	5,615,231	6371000	0	45	30
2	Tromso, Norway	20	70				0		
3	Baffin Island	-70	70				0		
4	Khaudum, Namibia	20	-20				0		
5	BlackSea, Danube	30	45				20		
6	Tromso, Norway	20	70				20		

Notice how or if the x values change for the same latitudes, e.g., Baffin Island vs Tromso, or the same longitude, e.g., Tromso to Khaudum.

Also notice how the coordinates for the Danube delta, on the Black Sea, and for Tromso change when you change the cetnral meridian



Calculate the great circle distance between Tromso and Baffin Island using the geographic coordinates, and the Eucalidian distance (square root of (Δx^2 plus Δy^2)) between Tromso and Baffin Island using the projected Mercator coordinates.

What is the difference, in percent of the great circle distance, for these two distances?

Do the same for the distance between Tromso and Khaudum.

What is the difference in percent, as above? Why do you think it is different from the Tromso-Baffin distance?

Formula for Mercator forward and inverse projections

Given longitude = λ, latitude = ϕ (all angles in radians)

Mercator projection coordinates are:

$$x = R \cdot (\lambda - \lambda_0)$$
$$y = R \cdot \ln (\tan (\pi/4 + \phi/2))$$

where R is the radius of the sphere at map scale (e.g., Earth's radius), ln is the natural log function, and λ_0 is the longitudinal origin (Greenwich meridian)

Inverse equation, from x, y to λ, ϕ:

$$\lambda = x/R + \lambda_0$$
$$\phi = (\pi/2) - 2 \cdot \tan^{-1}[e^{-y/R}]$$