

# The Last Homework Set!

## HOMWORK SET 21: MOTION ON EARTH Due Monday, December 4, 2023

### PROBLEMS FROM TM5

1) 10-7 Determine how much greater the gravitational field strength  $g$  is at the pole than at the equator. Assume a spherical Earth (6371 km). If the actual measured difference is  $\Delta g = 52 \text{ mm/s}^2$ , explain the difference. Look up other data about Earth and see if you can calculate a value closer to the given  $\Delta g$ .

Answer: 33.7 mm/s

2) 10-18 A British warship fires a projectile due south near the Falkland Islands during WWI at  $50^\circ\text{S}$ . If the shells are fired at  $37^\circ$  elevation with a speed of 800 m/s, by how much do the shells miss their target and in what direction? Ignore air resistance. [Hint: The final expression I get for the Coriolis deflection is shown.]

$$y_{\text{Coriolis}} = \frac{4v_0^3 \omega}{g^2} \sin^2(\theta) [3\sin(\lambda - \theta) + 2\cos\lambda \sin\theta]$$

Answer: TM5 gets 260 m to the east, I get 271 m

3) 10-19 Find the Coriolis force on an automobile of mass 1300 kg driving north near Fairbanks, Alaska ( $65^\circ\text{N}$ ) at a speed of 100 km/h (force is a vector!).

Answer: 4.76 N (the weight of  $\sim \frac{1}{2}$  a liter of water!)

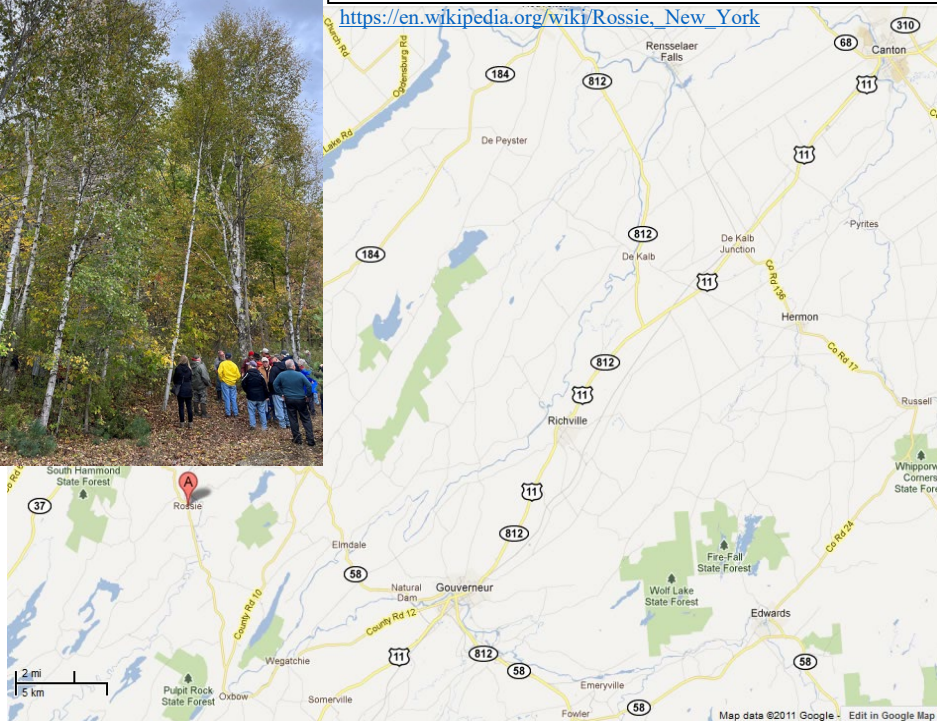
4) 10-22 Shot towers like the *Phoenix Shot Tower* in Baltimore (shown) were popular in the 18<sup>th</sup> and 19<sup>th</sup> centuries for dropping melted lead down tall towers to form spheres for bullets. The lead solidified while falling and often landed in water to cool the lead bullets. Many such shot towers were built in New York State and one survives in Rossie, NY shown on the map. For a shot tower in Rossie at  $\lambda = 44^\circ 23' \text{ N}$  that is the height of the Phoenix tower (71.4 m), determine how far and in what direction the bullets dropped from the center fell relative to the center of the tower. (Use Example 10.3) Answer: 9.44 mm to the east



Rossie tower  
10/8/23

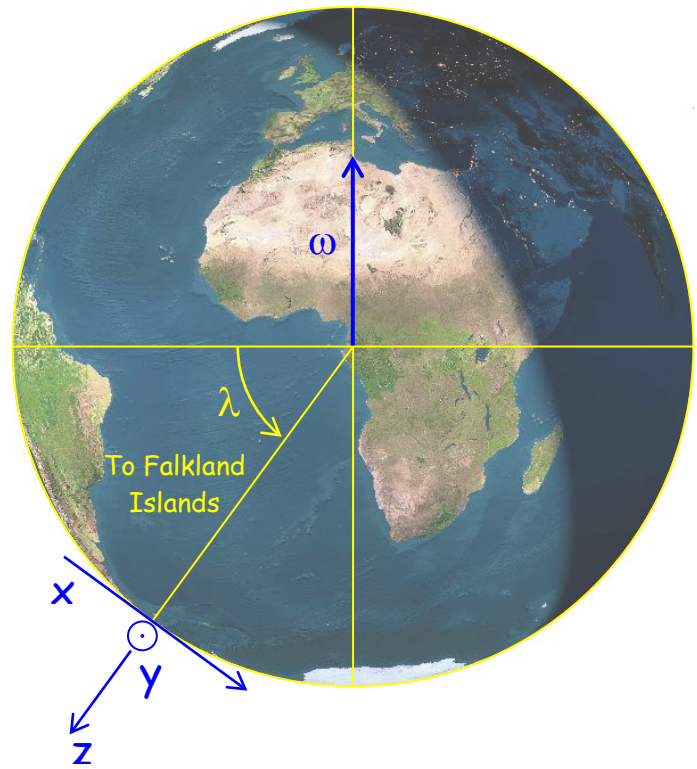
On a tour of Rossie industrial sites on 10/8/23 hosted by the St. Lawrence County Historical Society, no one knew whether or not the Rossie Towers (2) had been used as shot towers and it was not obvious at the site. It is cited on Wikipedia, but so far, there is no known local evidence one way or the other.

[https://en.wikipedia.org/wiki/Rossie,\\_New\\_York](https://en.wikipedia.org/wiki/Rossie,_New_York)

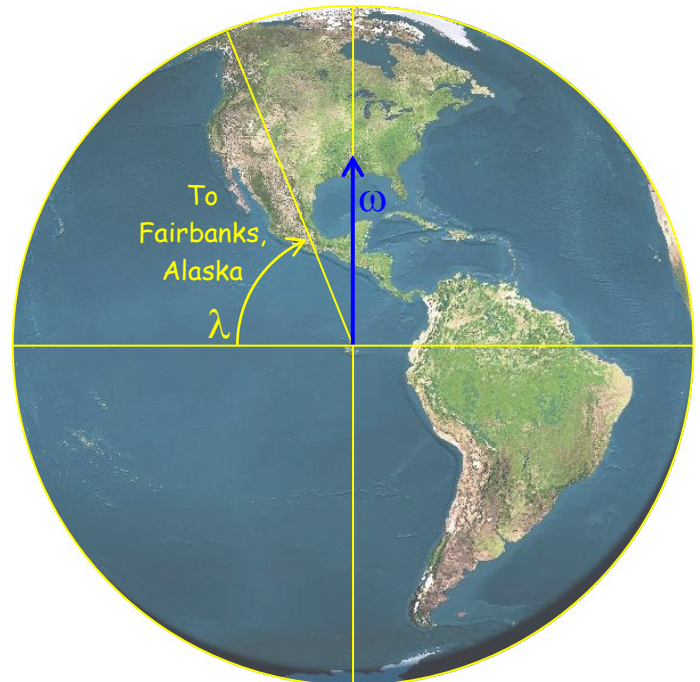


Helpful Coordinate Diagrams

TM5 Pr. 10-18) British Warship near the Falkland Islands ( $52^\circ$  S,  $58^\circ$ W)

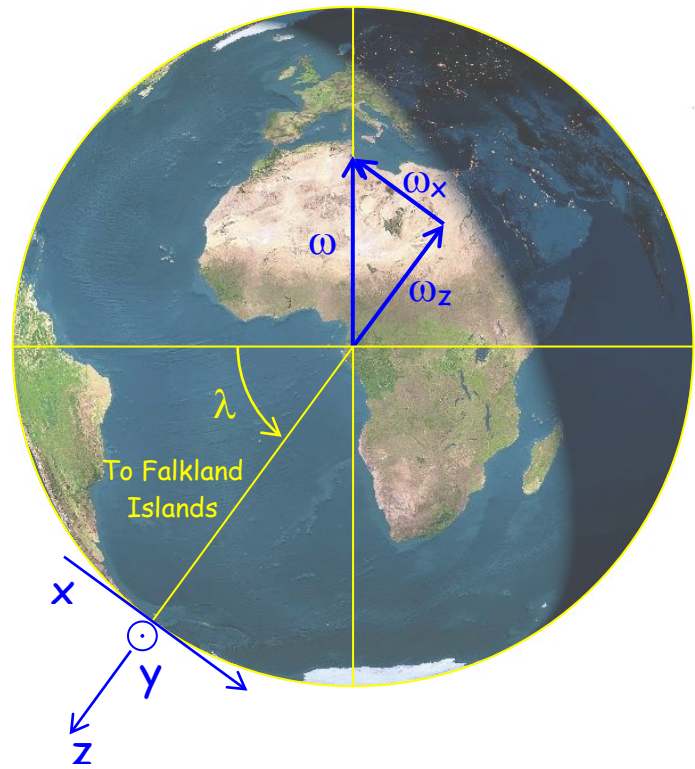


TM5 Pr. 10-19) Driver in Fairbanks, Alaska ( $65^\circ$  N,  $58^\circ$ W)



Helpful Coordinate Diagrams with Hints!

TM5 Pr. 10-18) British Warship near the Falkland Islands ( $52^\circ$  S,  $58^\circ$ W)



TM5 Pr. 10-19) Driver in Fairbanks, Alaska ( $65^\circ$  N,  $58^\circ$ W)

