

Quiz 7

Name: _____ Student Number: _____

CALCULATORS ALLOWED.

1. (6 marks) Rotation of Earth $I_{\text{sphere}} = \frac{2}{5} MR^2$ $M_{\text{Earth}} = 6 \times 10^{24} \text{ kg}$ $R_{\text{Earth}} = 6,400 \text{ km}$
a) What is the Earth's rotational angular momentum?

$$\begin{aligned} L &= I \omega \\ &= \frac{2}{5} MR^2 \omega \\ &= \frac{2}{5} 6 \times 10^{24} \text{ kg} (6.4 \times 10^6 \text{ m})^2 \cdot \frac{2\pi}{24 \times 3600 \text{ sec}} \\ &= 7.15 \times 10^{33} \text{ kg m}^2/\text{sec} \end{aligned}$$

- b) What torque would need to be applied to cause a nonrotating Earth to acquire this angular momentum in 10 seconds?

$$\begin{aligned} N &= \frac{\Delta L}{\Delta t} \\ &= \frac{7.15 \times 10^{33} \text{ kg m}^2/\text{sec}}{10 \text{ sec}} \\ &= 7.15 \times 10^{32} \text{ kg m}^2/\text{sec}^2 \\ &= 7.15 \times 10^{32} \text{ Nt m.} \end{aligned}$$

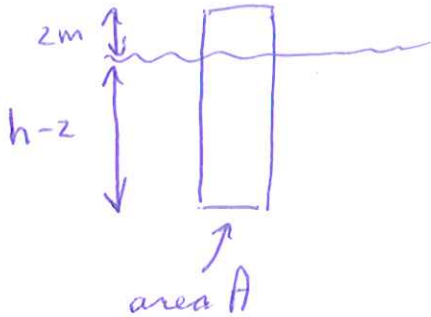
- c) If this torque were generated by applying a force at the equator, estimate the magnitude of this force.

$$\begin{aligned} \vec{N} &= \vec{r} \times \vec{F} \\ \therefore |\vec{F}| &= \frac{7.15 \times 10^{32} \text{ Nt m}}{6.4 \times 10^6 \text{ m}} \\ &= 1.12 \times 10^{26} \text{ Nt.} \end{aligned}$$

2. (4 marks) Arctic Ice

- a) Arctic ice thickness can be estimated by measuring the distance ice is above water compared to a nearby region of open water. Find the ice thickness if the ice is 2 meters above the water level. Ice Density = 0.92 gm/cm^3 .

Archimedes: Ice Weight = Weight Water Displaced



$$\rho_{\text{Ice}} A h g = \rho_{\text{water}} A (h-z) g.$$

$$\rho_{\text{Ice}} h = \rho_w (h-z)$$

$$h(\rho_{\text{Ice}} - \rho_w) = -z\rho_w$$

$$h = \frac{z\rho_w}{\rho_w - \rho_{\text{Ice}}}$$

$$= \frac{2 \text{ m } 1 \text{ gm/cm}^3}{0.08 \text{ gm/cm}^3}$$

$$\therefore h = 25 \text{ m}$$

- b) Estimate the rise in global sea level if the Arctic ice thickness changes from 1 meter to 2 meters due to global warming.

No change since volume water ice displaces = volume of water when it melts.